THE INTELLECTUAL OBSERVER.

APRIL, 1867.

ECONOMIC USES OF SHELLS, AND THEIR INHABITANTS.*

(*With a Tinted Plate.*)

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In the two former articles which appeared in the INTELLECTUAL OBSERVER (vol. x., No. iv., *November*, 1866, pp. 241—253, and vol. xi., No. i., *February*, 1867, pp. 18—30,) I gave some account of the "Form, Growth, and Construction of Shells," with illustrations of the most remarkable diversities which the mollusca present. I propose now to speak of the economic uses to which man has applied this class.

At almost the earliest period in which we discover evidence of the existence of man, we find the primitive races dwelling upon the sea-shore, and subsisting largely upon mollusca; leaving at one point shell-mounds of oyster-valves, associated with rudely-fashioned flint knives, employed in opening them; at another, the broken fragments of turbinated univalves, and the round stone hammers used in crushing the shell to procure the *bonne bouchée* it enclosed.

Nor did the mere cravings of hunger impel them to seek shell-fish as articles of food, for in the limestone caverns of France and Belgium numerous remains of shells of mollusca have been met with, pierced with holes, for the purpose of attaching them to some article of dress or head-gear.

Among the aborigines of the present day, in whatever region of the earth they dwell, the same economic uses of mollusca prevail, and their practices serve to throw much light upon the fragmentary remains of their pre-historic ancestry.

Shell-fish as articles of food.—No shell-fish has, probably, endured more severe havoc from mankind than the common

* From the Notes of the late Dr. S. P. Woodward, F.G.S., etc., and other sources.

oyster; for it is only in comparatively late years that it has received the protection of Mr. Frank Buckland, and become a subject for Parliamentary committees to discuss, and Government to legislate for.

The shores of Denmark and her islands are marked to this day by vast shell-mounds (kjökken-möddings), indicating the primitive taste for *Ostrea edulis*. No doubt vast strata of oyster-shells must exist beneath London, when we consider that from 20,000 to 30,000 bushels of "natives," and 100,000 bushels of "sea-oysters," were (ten years ago) annually supplied to the London market. If any falling off has occurred of late in the former kind, the latter have, no doubt, been brought in larger quantities to meet the demand. The Oyster Companies promise to make oysters as cheap as ever in another six or seven years. "Sea-oysters" (*i. e.*, oysters naturally grown) attain their majority in four years, but "natives" (*i. e.*, oysters artificially cultivated) do not reach their full growth in less than five or seven years. It was the bringing of immature oysters to market which has, to a great extent, produced the present scarcity of this article of food. Many other species of oysters are eaten in India, China, Australia, etc.

Pecten maximus—commonly known as "scallops" in the London market, "queens" at Brighton, and "frills" on the coasts of Dorset and Devonshire—are now almost as much eaten as oysters, but they require to be cooked first.

An allied species has received the name of "St. James's shell" (*Pecten Jacobæus*); it was worn by pilgrims to the Holy Land. The fossil Pectens found in the sub-apennine formation of Italy were supposed by early writers to have been dropped by these devout persons on the road. Parnell says of the hermit:—

> "He quits his cell; the pilgrim staff he bore,
> And fixed the *scallop* in his hat before."

The aged Pectens certainly are sedentary in their habit, as is testified by the mass of *Bryozoa*, *Serpulæ*, *Alcyonium*, and *Balani* attached to their upper flat valve. They do not, however, fix themselves like the oysters by the deep valve, but some species are moored by a byssus to stones, or the stems of the *Laminaria*.

The young Pectens swim freely by rapidly closing and opening their valves. The writer, when dredging with Mr. MacAndrew off Coruña, has seen *Pecten opercularis*, two inches in diameter, swim rapidly out of the dredge as it was hauled up alongside the boat.

Mytilus edulis, the common edible sea-mussel, although far less highly esteemed than the scallop or oyster, is nevertheless much in request as an article of food.

I have not been able to ascertain the consumption of mussels in London, but in Edinburgh and Leith it is estimated at 400 bushels annually. Dr. Knapp states that from thirty to forty millions are collected yearly in the Firth of Forth alone, and used as bait for the deep-sea fishery. They form no small item of consumption in the north of Ireland; boats-full being constantly sent to the Belfast market.

The common cockle (*Cardium edule*) is largely used in many parts of England for food. It is obtained at extreme low water on all sandy shores, living buried beneath the sand.

Many other species of bivalve mollusca are eaten abroad; for example, in North America, "hard" and "soft clams" (*Mya* and *Lutraria*); whilst the giant clam (*Tridacna gigas*) of the Indian Ocean, the shell of which often weighs upwards of 500 lbs., contains an animal weighing sometimes 20 lbs., which is stated by Captain Cook to be very good eating.

The Mactras are eaten by the star-fishes and whelks, and in the Island of Arran *Mactra subtruncata* is collected at low water to feed pigs upon.

Gnathodon cuneatus—a shell nearly allied to *Mactra*—was formerly eaten by the Indians.

The Solens, or "razor-fishes," are excellent articles of food when cooked.

The *Patella*, or rock-limpet, is much used by fishermen for bait. On the coast of Berwickshire nearly twelve millions have been collected yearly, until their numbers are so decreased, that collecting them has become tedious. In the north of Ireland they are used for human food, especially in seasons of scarcity. Many tons weight are collected annually near the town of Larne alone. (*Patterson.*)

The "oyster-catcher" (*Haematopus ostralegus*), a well-known sea-shore bird, does not subsist upon the oyster, as its name implies, but chiefly upon the *rock-limpet*. The adroitness which he displays in undermining these, far exceeds the rapidity of the most practised oyster-opener at a London fishmonger's.

The *Haliotis* abounds on the shores of the Channel Islands, where it is called the "Ormer," and is cooked, after being well beaten to make it tender. It is also eaten in Japan.

The whelk (*Buccinum*) is dredged for the market, and is also used as bait by fishermen. Many tons' weight of whelks are annually consumed in the streets of the poorer parts of London.

The "buckie" (*Fusus antiquus*) is extensively caught in Scotland for the markets, being more highly esteemed than the *Buccinum*. It is the "roaring-buckie," in which the sound of the sea may always be heard.

The *Litorina litorea* is collected in immense quantities around our shores, and is known by the familiar name of "winkles," or "pin-patches." This species is oviparous, and inhabits the lowest zone of seaweed between tide-marks. The *Litorina rudis* frequents a higher region, where it is scarcely visited by the tide; it is viviparous, and the young have a hard shell before birth, in consequence of which the species is not eaten.

Both the *Litorina* and *Trochus* are the food of the thrush, in the Hebrides, during winter.

The *Amphibola*, a mollusk allied to *Ampullaria*, is eaten by the New Zealanders.

The land-snails, such as the *Helix arbustorum*, and *H. aspersa*, are the favourite food of the blackbird and thrush, and a smaller species of *Helix*, common on sandy pastures, is said by Patterson to be eaten in vast numbers by the sheep when grazing, and to form a very fattening kind of food.

Another land-snail (*Helix pomatia*) was highly esteemed by the Romans, who fattened them as articles of food; they are still found abundantly in many localities in the south of England, especially about the sites of old Roman villas in Gloucestershire. They were at one time appreciated by our ancestors, and when boiled in spring water, and seasoned with oil, salt, and pepper, they make a dainty dish.* Our neighbours the French still eat them extensively, as do also the poorer classes in Spain and Italy; the Brazilians also eat land-snails.

Everyone who visits the Paris Exhibition should taste a dish of snails; they are most delicious.

The flesh of the Cuttle-fish, especially that of the arms, is considered highly nutritious. It was greatly prized by the ancients, and, though not used in this country, is still much sought for in other parts of the world, and regularly exposed for sale in the markets at Naples and Smyrna, and the bazaars of India. In the curious Japanese book, from which Fig. 1 of our Plate is taken, there is a picture of a man in a boat engaged in catching cuttle-fishes with a spear, and also of a fishmonger's shop in Japan, at which a number of enormous cuttle-fishes are represented hanging up for sale. The writer has seen three species of cuttle-fish exposed in the markets of Santander, Coruña, and Gibraltar, viz., *Onychoteuthis Banksii*, Leach., *Sepia officinalis*, Linn., and *Loligo vulgaris*, Lam.

Our most common species (*Loligo vulgaris*) forms the bait with which one half of the cod taken at Newfoundland is caught. It is also commonly used for bait by the Cornish fishermen. (*Couch.*)

From their pelagic habits, they furnish the principal part

* Gray's *Turton's Manual*, pp. 135-6.

of the food of the dolphins and cachalots, as well as of the albatross and larger petrels.

My friend, Mr. R. Warington, of Apothecaries' Hall, has informed me that the test of the genuineness of "spermaceti," as imported, is, that it is full of the undigested beaks of the calamary, upon which the sperm-whale feeds.

The undigested remains of fossil cuttle-fishes are frequently noticed entombed within the ribs of the *Ichthyosauri* and *Plesiosauri* of our Lias, showing that then, as at the present day, to eat, and to be eaten, was the general law of nature.

Having briefly pointed out a few instances of the manner in which the mollusca subserve the good of mankind as articles of food, I will now proceed to speak of the various other uses to which they have been applied in medicine, commerce, the arts, and manufactures.

Shells used in Medicine.—In the *Pharmaceutical Journal* for February, 1862, my friend, Mr. Daniel Hanbury, F.L.S., published some interesting "Notes on Chinese Materia Medica," from which I extract the following:—

"*Shih-keue-ming*; shells of *Haliotis funebris*, Reeve; *Puntsaou*, Fig. 969, etc. This shell is stated to occur on the coasts of Fuh-kien and Kwantung. Messrs. Cuming and Lovell Reeve (both since deceased), who have examined it, concur in referring it to *Haliotis funebris*, a New Holland species figured by the latter gentleman, in his beautiful *Conchologia Iconica*, sect. *Haliotis*, pl. xii., f. 38.

"*Shih-yen*; Fossil shells; Tatarinov. *Cat. Med. Sinens.*, p. 54; *Puntsaou*, Fig. 65. These fossils have been examined and described by Mr. Thomas Davidson, to whose account and figures, in the *Proceedings of the Geological Society* (June 15th, 1863), I refer the reader who wishes for full details. The actual specimens are in the British Museum. Mr. Davidson remarks that the specimens belong to eight Devonian species, seven of which are common to several European localities, among which may be mentioned Ferques and Néhou (France), Belgium, and the Eifel, but they are not found all existing together in any one of these localities. In external aspect the Chinese specimens most resemble those from Ferques, where, however, two of them, *Cyrtis Murchisoniana* and *Rhynchonella Hanburii*, have not yet been discovered.

"If to these be added two described by M. de Koninck, the total number of Chinese Devonian types at present known will amount to ten species, viz.:—3 of *Spirifer*, 2 of *Rhynchonella*, 1 *Productus*, 1 *Crania*, 1 *Cornulites*, 1 *Spirorbis*, and 1 *Aulopora*. These fossils are asserted to occur in the southern province of Kwang-si, where coal is also met with"

Onycha—*Blatta Byzantina*.—In old Pharmacopeia an article

is described from the Levant under the name of "*Blatta B.*"* Dr. Lister laments the loss of this article from the *Materia Medica*, believing it "to have been a good medicine, from its strong aromatic smell." Mr. Hanbury procured samples in Damascus in October, 1860, and a friend bought some in Alexandria a few months before. This oriental drug is still found in the bazaars of the East, though not much in demand.

It appears to be identical with the *Onycha* of Scripture (Exodus xxx. 34), one of the ingredients of the sacred perfume (W. Smith, *Dict. Bib.* iii. 635). *Dioscorides* describes the onyx (*Onycha*) as the operculum of a shell-fish, resembling *Purpura*, found in India; the best kind was obtained from the Red Sea. (*Pliny.*)

It really does consist of the horny opercula of whelks (*Purpura* and *Murex*), mixed with opercula of a species of *Fusus* and of *Strombus* (*lentiginosus*?), called by the Arabs "devils' claws," on account of their serrated edges. It does not appear to deserve the character of an "excellent odour" ascribed to it.

Humboldt tells us that the small operculum of a species of *Turbo*, flat on one side, and round on the other, has long been regarded by certain races of South America as possessing supernatural properties.

The "sea-hare" (*Aplysia depilans*) was formerly held in great dread among the superstitious fishermen of our coasts. It was said that its touch would cause the hair to fall off, and that the purple fluid it emits when touched was a deadly poison, the operation of which was inevitable. (*Patterson.*)

Mollusca applied in Commerce, Arts, and Manufactures.—All the cuttle-fishes possess an ink-bag, from which at pleasure they can emit a fluid which darkens the water, and favours their escape from their enemies. The prepared ink of the cuttle-fish is capable of being made into a pigment. This is the "sepia" of commerce.

The ink of the *Sepia* was formerly used for writing with (*Cicero*), and even after being entombed for centuries, it preserves its powers.

Dr. Buckland supplied some of this ink from a fossil *Belemnoteuthis* to an eminent painter, who, after using it, inquired from what colourman such excellent sepia might be procured. But "sepia" is not the only colouring matter which the mollusca furnish for the use of man. The dye used in the manufacture of the celebrated "Tyrian purple" of the ancients was obtained from certain species of *Murex*. The small shells were bruised in mortars, and the animals of the larger ones

* See Matthiolus' *Comment in Diosc.*, ii., 8, figures of *Blatta B.* also in Pomet's *Hist. des Drogues*, 1694.

were taken out. Heaps of broken shells of *Murex trunculus*, and cauldron-shaped holes in the rocks, may still be seen on the Tyrian shore. On the coast of the Morea there is similar evidence of the employment of *Murex Brandaris* for the same purpose. Many species of *Purpuræ* likewise produce a fluid which gives a dull crimson dye.

One of the earliest uses to which the shells of mollusca appear to have been applied was that of articles of dress.

In M. M. Lartet and Christy's *Reliquiæ Aquitanicæ* (Part iii. August, 1866. B., Pl. v., figs. 15—20), we find illustrations of several shells, viz., *Cypræa pyrum*, *Pectunculus glycimeris*, *Arca Breislaki*, which show clearly, by their having been perforated, that they had been worn either as ornaments or charms by the aborigines who inhabited the cavern of La Madelaine. The custom of using shells, etc., as necklaces, or other personal decorations, is common, not only amongst savages, but even amongst *civilized* races at the present day. In this case the shells have been obtained *not from sea or river*, but from the Faluns of Touraine or Bordeaux, deposits of Miocene age, rich in fossil marine shells, many of which are so well preserved as to retain the glazed surface seen in recent specimens. Dr. Fischer, of Paris, has determined as many as five species in the caverns of Perigord.

It is interesting to record, that in the cavern of Bruniquel, department Tarne et Garonne, an Oolitic Belemnite, having its sides squared by grinding, was found among the *debris;* also an Ammonite and a *Gryphæa*, probably introduced by children as toys. Perforated recent marine shells were likewise numerous. These relics are preserved in the British Museum. Shells are at the present day as greatly in demand for ornamental purposes as in pre-historic times.

The Chinooks of Oregon ornament their noses and ears with shells of *Dentalium*.

The Friendly and Fiji islanders wear the orange cowry (*Cypræ aurora*) as a mark of chieftainship.

The natives of Flinders Island and the New Zealander polish the *Elenchus* into an ornament more brilliant than the "pearl ear-drop" of classical or modern times.

Cypræa shells are worn as a head-dress by the natives of New Guinea.

The time would fail in which to tell all the various methods used in applying shells as ornaments to the head, dress, and person. Every book of travels in Africa, America, or to the South Sea Islands, teems with such illustrations. Nor does India furnish an exception to the rule; for there the female children have their arms and ankles, from infancy, encircled with broad shell-bands cut from the whorls of the great

Turbinella pyrum, and our Sepoy troops wear necklaces made from the canal of the same shell, as part of their parade uniform! (See Indian Museum Collection, Whitehall.)

One very ancient use of shells was as a medium of currency, and among certain tribes this custom remains in force even at the present day. In Oregon the currency consists of strings of the shells of *Dentalium*.

Some of the North American Indians used to make coinage (*wampum*) of the seaworn fragments of *Venus mercenaria*, by perforating and stringing them on leather thongs.

The money-cowry (*Cypræa moneta*), is a native of the Pacific and Eastern seas. Many tons' weight of this little shell are annually imported into this country, and again exported for barter with the native tribes of Western Africa. In the year 1848 sixty tons of the money-cowry were imported into Liverpool.

The use of turbinated or spiral shells as trumpets or horns to sound an alarum with, appears to be of most ancient date, and cosmopolitan in extent. The practice is followed among the African aborigines, the natives of the Eastern Archipelago, and New Zealand, and, according to the Japanese picture which we reproduce in our Plate (Fig. 1), it is followed in Japan at the present day.

"The sound of the trumpet or shell (writes Ellis), a species of murex (*triton*), used by the priests in the temple, and also by the herald, and others on board their fleets, was more horrific than that of the drum. The largest shells were usually selected for this purpose, and were sometimes above a foot in length, and seven or eight inches in diameter at the mouth. In order to facilitate the blowing of this trumpet, they made a perforation, about an inch in diameter, near the apex of the shell; into this they inserted a bamboo cane, about three feet in length, which was secured by binding it to the shell with finely-braided cinet; the aperture was rendered air-tight by cementing the outsides of it with a resinous gum from the bread-fruit tree. These shells were blown when any procession marched to the temple, at the inauguration of the king, during the worship at the temple, or when a tabu, or restriction, was imposed in the name of the gods. We have sometimes heard them blown. The sound is extremely loud, both the most monotonous and dismal that it is possible to imagine."* Specimens of these may be seen in the Shell Gallery, and also in the Ethnographical Room at the British Museum.

Shell-Cameos.—The fountain-shell of the West Indies, *Strombus gigas*, L., is one of the largest living univalve shells, weighing sometimes four or five pounds; its apex and spines

* *Polynesian Researches*, vol. i., p. 283.

are filled up with solid shell as it becomes old. Immense quantities are annually imported from the Bahamas for the manufacture of cameos, and for the porcelain works; 300,000 were brought to Liverpool alone in the year 1850.

The queen-conch (*Cassis Madagascariensis*), and other large species, are also used in the manufacture of shell cameos.

The best shell for cameo-engraving is the *Cassis rufa*, Brug., from West Africa. This is the species, with the cameo cut upon it, represented at Fig. 2 in our Plate. It was drawn by the late Dr. S. P. Woodward, from a specimen preserved in the Shell-Gallery of the British Museum, where many other illustrations of the economic uses of shells may be seen. The secret of cameo-cutting consists simply in knowing that the inner stratum of porcellanous shells is differently coloured from the exterior. Cameos in the British Museum, carved on the shell of *Cassis cornuta*, are white on an orange ground; on *C. tuberosa* and *Madagascariensis*, white upon dark claret colour; on *Cassis rufa*, pale salmon-colour on orange; and on *Strombus gigas*, yellow on pink.

The conversion of shells into receptacles for various things (both sacred and profane) should not be lost sight of here.

Some specimens of *Turbinella rapa*, from the Malabar coast, are exhibited in the Shell-Gallery. They have been carved externally, and scooped out internally, and were used, says Sir J. Emerson Tennant, to contain the sacred oil, employed in anointing their priests.

In Zetland, the *Fusus antiquus*, suspended horizontally by a cord, is used as a lamp, the canal serving to hold the wick, and the body of the shell the oil.

On the western coast of South America, there is a limpet which attains the diameter of a foot, and is used by the natives as a basin.

But perhaps the most amusing piece of native adaptation is an *Achatina* shell from Africa, which an ingenious native has fitted with a plug, and used as a snuff-box! (British Mus. Coll.)

Numberless are the applications of shells as sinks to nets, barbs to harpoons, and hooks, and in one case to make an artificial bait to catch cuttle-fishes with.

In Ellis's *Polynesian Researches*, vol. ii., p. 292, he gives an account of fishing for cuttle-fish with an artificial bait, formed of a piece of hard wood, to which a number of the most beautiful pieces of the cowrie, or tiger-shell, are fastened one over another, like the scales of a fish or the plates of a piece of armour, until it is about the size of a turkey's egg, and resembles the cowrie. It is suspended in a horizontal position by a strong line, and lowered by the fisherman from a small canoe until it nearly reaches the bottom. The fisherman continues

gently to jerk the line, when the cuttle-fish, attracted by the appearance of the cowrie, darts out one of its arms, which it winds around the shell, and fastens among the openings in the plates. The jerking being continued, the fish puts out another and another arm, till it has quite fastened itself to the shell-bait, when it is drawn up into the canoe and secured.

Pearl-producing shells.—The pearl-mussel, *Unio margaritis ferus*, afforded the once famous British pearls. It is found in the mountain streams of Britain, Lapland, and Canada, and is used for bait in the Aberdeen cod-fishery. The Scotch pearl-fishery continued till the end of the last century, especially in the river Tay, where the mussels were collected by the peasantry before harvest-time. The pearls were usually found in old and deformed specimens. Round pearls, about the size of a pea, perfect in every respect, were worth £3 or £4. An account of the Irish pearl-fishery was given by Sir R. Redding in the *Philosophical Transactions*, 1693. The mussels were found set up in the sand of the river-bed, with their open side turned from the torrent; about one in a hundred might contain a pearl, and one pearl in a hundred might be tolerably clear.

Hyria is the shell which the Chinese employ to produce artificial pearls, by the introduction of shot, etc., between the mantle of the animal and its shell. A *Hyria* in the British Museum has a number of little josses made of bell-metal, now completely coated with pearl, in its interior.

Pearls are produced by many bivalves, especially by the oriental pearl-mussel (*Avicula margaritifera*). They are caused by particles of sand, or other foreign substances, getting between the animal and its shell; the irritation causes a deposit of nacre, forming a projection on the interior, generally more brilliant than the rest of the shell. Completely spherical pearls can only be formed loose in the muscles, or other soft parts of the animal. The Chinese obtain them artificially, by introducing into the living mussel foreign substances, such as pieces of mother-of-pearl, fixed to wires, which thus become coated with a more brilliant material. Similar prominences and concretions—pearls which are not pearly—are formed inside porcellanous shells. These are as variable in colour as the surfaces on which they are formed. They are pink in *Turbinella* and *Strombus;* white in *Ostrea;* white or glossy, purple or black, in *Mytilus;* rose-coloured and translucent in *Pinna.* (See specimens in Shell Gallery, British Museum.)

The pearl-fisheries of the Persian Gulf and Ceylon give employment annually to several hundred boats and many

thousand men. The entire amount of revenue derived from the pearl-fisheries of Ceylon in nine years (from 1828 to 1837) amounted, according to Mr. James Steuart, the Inspector of Pearl Banks, to £227,131, but it has since decreased very considerably.

The shells of nearly all the *Turbinidæ* are brilliantly pearly when the epidermis and outer layer of the shell are removed. Many of them are used in this state for ornamental purposes.

The shell of *Haliotis* is also much used for inlaying papier-mâché work, etc.

Nor have we yet exhausted the list of uses to which the mollusca are applied. In many districts where lime is scarce, shells are used instead. Vast quantities are thus consumed on the coast of Chili and Peru.

The *Cerithium* (*Terebralia*) *telescopium* is so abundant near Calcutta as to be used for burning into lime. Great heaps of it are first exposed to the sun, to kill the animals, and then burnt. In some places they are so plentiful as to be used for road making.

Sir Charles Lyell tells us there are banks of the dead shells of *Gnathodon cuneatus*, three to four feet thick, twenty miles inland. Mobile is built upon one of these shell-banks. The road from New Orleans to Lake Pont-Chartrain, a distance of six miles, is made of Gnathodon shells, procured from the east end of the lake, where there is a mound of them a mile long, fifteen feet high, and twenty to sixty yards in width; in some places it is twenty feet above the level of the lake.

If anyone should reflect upon the *Mollusca* as undeserving so much notice, and mention the *Teredo* as an instance of a destructive member of the class, let him read of the utility of another, the common mussel, in maintaining the long bridge of twenty-four arches across the Torridge river, near its junction with the Taw, at the town of Bideford in Devonshire. At this bridge the tide runs so rapidly that it cannot be kept in repair with mortar. The corporation, therefore, keep boats employed to bring mussels to it, and the interstices of the bridge are kept filled with mussels. It is supported from being driven away by the tide entirely by the strong threads of the byssus which these mussels fix to the stonework.

The *Pinna* of the Mediterranean spins a byssus so long and fine that it is mixed with silk, and spun into gloves, caps, etc., at Taranto.

Although the British Museum collection has far higher claims upon the scientific man than upon the mere utilitarian, yet, as a large proportion of the visitors to that institution are *not* scientific, we cannot but feel indebted to Dr. Gray for the

very interesting and instructive series of specimens illustrating the economic uses of shells which he has caused to be exhibited there.

Explanation of Plate.

Fig. 1.—Japanese swine-herd blowing a Triton shell. Copied by the late Dr. S. P. Woodward from a rare and curious Japanese Book of Travels in Japan, preserved in the library of the British Museum.

Fig. 2.—Shell of *Cassis rufa*, with cameo (representing Raphael and Fornarina) engraved upon its surface. Drawn by the late Dr. S. P. Woodward from a specimen in the shell gallery of the British Museum.

The above have been carefully engraved by Mr. G. R. De Wilde, whose skill as an artist is well known.

FATIO ON FEATHERS—THEIR DECOLORATION.

In our December number (p. 377) we give an account of the important microscopical researches made by M. Fatio on the "Forms and Colours of Plumage," and we have now to complete the subject by further extracts from M. Fatio's paper.

M. Fatio commences a chapter on "Decoloration" by explaining the extravasation of pigment spoken of in the earlier part of his memoir. He says, "we have seen that in certain cases of coloration by change of colour, the first pigment, in a state of solution, was driven out by another and deeper pigment, and forced to extravasate itself; and we have also seen in other cases of coloration by augmentation of intensity, that the dissolved pigment diffused itself in the spaces produced by the absorption and evaporation of moisture, and that there was no extravasation until the coloration was complete. We can therefore understand that each colour, as well as each feather, has a limited duration while the bird is alive, and one colour, without being driven away by another, will nevertheless depart in its own turn. The feather which has performed its part succumbs under the efforts which it has made; its tissues deteriorate, and its pigment after being completely dissolved, disappears, driven away by fresh accessions of greasy matter."

"If a feather grown in the autumn does not fall in the spring, and is not able to undergo a fresh coloration, it must necessarily suffer a decoloration, more or less rapid and complete."

"If the tissues which are entirely filled with a coloured solution are able to distend themselves under the influence of moisture, no extravasation will occur until the new spaces are filled by the freshly dissolved pigment. But there is a limit to the cortical development of a feather, nearer or more remote. Optical feathers,* which possess most of this cortical substance, exhibit a later and less complete extravasation, while mixt feathers, possessing less of this substance, exhibit it more speedily."

"A young gull, *Larus ridibundus*, has in the summer a first plumage which is almost entirely brown, and in its first spring it is nearly all white, without any true moult having occurred in the greater part of its feathers. An observation of the plumage of this bird at the end of autumn discloses all the transitions between the two states of colour, and the microscope explains the cause of the transformation. The brown barbs and barbules are filled with a very diffused brown pigment; a brown dust covers the exterior of each part of the feather in proportion to the extent of the decoloration, not being seen on those which are quite brown or quite white. The decoloration pursues an opposite course to that of the coloration; it proceeds from the base towards the extremities, and from the centre to the periphery, instead of moving from the borders towards the middle of the feather. It is a continuous change of a colourless grease for a coloured pigment, of which at last only a little remains in the centres, giving a slight tint to the feather.

"Similar phenomena occur in most of our birds, and to such actions we must ascribe the case mentioned by Brehm of some starlings, in which a black colour was hidden under a white external dust." If we place under the microscope, between two pieces of glass, a feather in process of decoloration, and a drop of oil, the process may be seen going on, made more active by slight heat and retarded by cold.

"In spring, we often see young gulls whose white livery is much less advanced than that of others of the same age: they are individuals in which the decoloration commenced in the autumn has been arrested by the extreme cold. The deeper a feather lies, and the more it is sheltered, the more promptly extravasation takes place during the life of the bird. The grease proceeding from the bird's body produces a coloration from the periphery towards the centre, when it meets with pigment that is already dissolved, or tissues already filled, because only one exchange is possible; and the same grease produces a coloration from the periphery towards the centre, because it is at the extremities that it finds first, and chiefly,

* For an explanation of these terms, see the previous paper, Dec. No., p. 377.

the moisture and light which are necessary to effect a solution of the latent pigment. At the same time extravasation occurs in the hidden parts of the feather, likewise producing a decoloration towards the extremities moving in a contrary direction and encountering the other action."

"Of these two processes of decoloration, the second sometimes overpowers the first, and under certain conditions it sometimes happens that a feather becomes gradually decoloured from the summit to the base. As is the case with extravasation, the coloration is always more rapid in mixt feathers. The quickest coloration is most often due to abundance of the greasy matter in a bird, aided by favourable conditions of atmospheric moisture and temperature. The changes are also often rendered more striking by an exceptionally rapid fall of the fragile tips, which mask, while they remain, the transition that has taken place in adjacent parts." The occurrence of albinism, which is natural in some birds, may be accounted for by the accidental operation in others of the causes just explained.

M. Fatio thinks that under the influence of violent emotion an unusual influx of greasy matter may occur, and under suitable conditions of temperature and moisture, may give rise to a sudden appearance of albinism.

"The extravasated coloured dust must not be confounded with the true external colouring which the feathers of some birds exhibit. Many species of different orders show, in fact, accidentally or regularly on certain parts of their bodies, most frequently on their lower surfaces, different colorations, more or less concentrated, and more or less persistent, resulting from friction against certain mineral or vegetable bodies of which they are particularly fond. This external painting has sometimes given rise to the creation of false species. It arises most frequently from the soil on which the bird lives, the food it obtains, and the kind of life it leads. M. Meves, in a memoir which was translated by Gloger, and inserted in the "Journal of Ornithology" (*Journal für Ornithologie*), studied the brown and orange coloration of the vulture (*Gypaetos*) of the south. He described this coloration as external, and capable of removal by an acid wash, and he attributed it to the repeated bathings of the bird in ferruginous springs. Eugene von Homeyer also noticed a brown external coloration amongst the cranes in their nesting time in the north, and he ascribed it to the marshy soil with which the birds covered themselves by means of their beaks. Meves has likewise noticed the same thing, and adds that it is perceptible (comes off?) when touched. Many ducks also acquire a rosy tint on the belly, from the vegetation on which they rest. Some small birds in like manner become of

variegated colours on their breasts and bellies, either from the materials of their nests, or from that of the hole which they inhabit. Thus in spring I have seen the *Parus borealis* almost completely red on its lower surfaces. Lastly, an external colour, attaching especially to the throat, sometimes arises from coloured food, as when the throat and breast of the nutcracker assumes a dark rust colour when, during the frosts, it comes down to the valleys and feeds greedily on the hazel-nuts, in which it delights."

CONCLUSIONS.

"I have pointed out the principal agents which modify feathers, and their mode of action. I have also shown how these same agents can sometimes produce varied effects under different conditions; and lastly, I have shown how a certain equilibrium between external and internal condition is necessary to keep the coloration of a species within typical limits."

"I cannot assert that I have foreseen all the divers causes of natural or accidental variation, nor can I pretend to have submitted to examination all the different feathers which birds may present. I have passed by some modifications purely ornamental; but I think I have investigated the most natural and ordinary forms, and that new phenomonon may easily find their explanation upon the principles thus disclosed."

* * * * * * *

"My explanation comprehends not only the variation of colours more or less striking according to locality and climate, but also the formation of race and varieties according to the prevalence of different conditions of moisture, temperature, and inclination."

SILVERED MIRROR TELESCOPES—THEIR MERITS AND DISADVANTAGES.

The introduction of silvered mirror telescopes in this country upon M. Foucault's plan, seems to have originated with amateurs. A London optician, indeed, exhibited a few years ago in his window a French pattern of small size in a square mahogany case, and at a price considerably beyond its merits, but it remained for Mr. Browning to make them, in an improved form, a regular article of trade. Mr. Webb, in our pages, was one of the first astronomers who directed the attention of English observers to the advantages arising from their construction, and to him belongs the merit of having introduced Mr. With's mirrors to general notice and admiration. Our readers will also recollect interesting communications from Mr. Bird, who constructed a large and fine-silvered mirror telescope for his own use. A sufficient time has now elapsed since Mr. Bird, Mr. Cooper Key, and Mr. With turned their attention to these instruments, and since telescopes with mirrors made by the latter, and admirably mounted by Mr. Browning, have been in use, for some definite replies to be given to numerous inquiries concerning the merits and disadvantages of this construction.

Two facts are now established, first, that the mirrors produced by Mr. With leave nothing to be desired in point of accuracy of form. Weather permitting, and *their mounting being good*, they are on the whole more than equal to achromatics of the same aperture in point of dividing power and definition, and in point of light they approximate to achromatics much more closely than the older telescopes with mirrors of speculum metal, which are more easily affected, in an unequal manner, by changes of temperature. A 6¼-inch silvered mirror in fair condition has more light than a 5¼ achromatic, and readily divides stars which few achromatics of its own aperture will touch. Thus, Mr. Slack's 6¼ telescope on *good* nights has several times distinctly split γ^2 Andromedæ, with about 350, and this star is easy with Mr. Webb's 9¼. In the matter of cost the new telescopes afford a happy contrast to the enormous price of fine achromatics—the larger sizes can be had, with fine equatorial mountings, for a fraction of the cost of an achromatic object-glass capable of doing the same work.

The advantages of the silvered mirror instruments of the Browning and With construction are cheapness, short focal length, with corresponding facilities in use, absence of the chromatic errors, of refractors, and absence of spherical

errors, from Mr. With's extraordinary skill in giving them the true form. Beyond this, it may be stated that the cell mounting devised by Mr. Browning, and his method of supporting the plane mirror, or prism, secures permanent good performance in any position, and closely approximates the sort of definition of large stars to the neatness obtained by first class and moderate-sized refractors.

It is the disadvantages of the system that we are most often requested to elucidate, and we have waited for some time in order to estimate them as fairly as possible. First comes the question, Is it not troublesome to keep a silvered mirror telescope in order? and we answer, *Certainly not*, as they are made by Mr. Browning.

A badly-mounted refractor is a great nuisance, but it is nothing in abomination and vexation to a badly-mounted reflector, which will keep its owner in an optical purgatory of a most unpleasing kind. By making the mirrors of very thick glass, and mounting them in the cells figured in a former number, Mr. Browning's reflectors are much like achromatics, and indeed from the glass not being thinned off at the edges, as in the double convex lens of achromatics, the chance of flexure is much less. Mr. Browning's cell answers perfectly for sizes from 6½ to 10½, and would probably do well for bigger instruments, though *monsters* might require other special contrivances to guard against flexure. There is no difficulty in adjusting these telescopes if slightly deranged. The screws are very manageable, and the test of true adjustment very easy. The instrument would, of course not, be out of order when it comes from the maker, but if the mirror is taken out of the cell, and the prism or flat dismounted, a very few minutes will suffice to put both right again. The plan is to remove the glasses from a deep eye-piece, and look through the small hole left in the brass work at the prism, or plane mirror, with a Barlow lens interposed. The eye readily detects want of centering, and the motions to obtain it are simple and easily understood by inspection of the parts. Thus we do not see that any one accustomed to philosophical instruments need be at all afraid of the new reflectors on this ground.

Then comes the question of keeping the thin film of silver in order. On this matter we have made divers experiments, and incline to the simplest treatment—that of using the mirror as if it were a fine achromatic object-glass—covering it up when out of use, and leaving it alone, with a rare and occasional wiping. This remark applies only to telescopes sheltered in some moderately good observatory. If used out of doors, it would probably be advisable to take the mirror indoors in its

cell, and keep it in a box when out of use, in a dry, cool place.

We left a mirror in our telescope all through the damp, foggy, and rainy weather of last year, protected first by a cover over the mouth of the tube, and secondly by an American cloth case over the instrument, and very little harm was done to the silvering. During a series of thick murky fogs we left some pieces of silvered mica freely exposed in the observatory, and they soon exhibited rainbow colours, while the protected mirror displayed no tarnish. Constantly taking a mirror in and out is very troublesome, and has the disadvantage that the instrument is not ready for those sudden observations that are often successful in changeable weather. We were, therefore, anxious to find out what would be the result of the treatment mentioned, and it seems that a mirror so circumstanced and freely used on damp nights, if anything is visible, will keep its lustre with an occasional rubbing for a considerable time. Ours was very little the worse for a year's use, and would probably have lasted at least a year longer, but for a special purpose we washed the silvering off.

Having experimented on silvering these glasses, we can affirm that no one accustomed to chemical processes need be afraid of failure, though the best possible silvering, perfectly free from specks, is of course a work of skill. The probable defect of amateur silvering will be the occurrence of a few spots and specks quite unimportant to optical performance. There may also be a tendency of some parts to be weaker than others, and to give way first after a succession of rubbings. It is essential that no rubbing shall ever be administered unless the mirror is perfectly *dry*. If wet or damp, off comes the silver with a touch, though when dry it may be rubbed like a spoon.

It is useless to try the silvering process in very cold weather. A warm day is clearly the most favourable; excess of cold prevents the adhesion of the film. The re-silvering process is cheap, whether done by the amateur, or performed for him by Mr. With, and when the mirrors are packed in suitable boxes, they can travel without risk.

When the silver begins to go, fine cobwebby cracks appear, but they do no harm for many months; and even in the atmosphere of Birmingham, with its thousands of chimneys pouring out all imaginable smokes and vapours, Mr. Bird finds the silvering stand for a considerable time. London atmosphere, as we have found, is far less destructive than might be expected.

Among the disadvantages of the silvered mirror telescopes, must be reckoned that plague of all reflectors, chimney cur-

rents in the tube. These may be greatly diminished by two means—first, having the tube larger than the mirror; and secondly, using the telescope out of doors, or in a form of observatory, which permits a ready equalization of its internal temperature with that of the outer air. Small revolving domes, with narrow slits, maximize the difficulty, and in awkward states of the weather render satisfactory performance impossible. All sources of optical disturbance increase rapidly with the size of the instrument, whatever be its construction, and the larger sizes require the best conditions and the most care. Under the same circumstances of *disadvantage*, reflectors may be expected to work rather worse than refractors with close tubes, though the difference is slight.

With moderate sizes, in good weather, the chimney currents of the new reflectors are scarcely noticeable, but when bitter east winds blow through a warmer atmosphere, they become very troublesome, and on the same nights no refractors will perform well.

We cannot look upon silvered mirror telescopes as only *substitutes* for refractors. If they have certain peculiar disadvantages, they have also peculiar merits, and those who get used to them feel no desire to change. The inconveniences of refractors eight, ten, twelve, fourteen feet long, are very serious, while reflectors of equal power are manageable and handy. A revolving eye-piece is indispensable to comfortable working. With it there are no awkward positions for the observer; without it many that are painful and perplexing. It is a very difficult task to have all the adjustments so perfect that a rotation of the eye-piece effects no displacement of the image. The adjustments may be so good that stars of less than 1″ apart, may be readily divisible in all positions of the instrument, and yet the rotation of the eye-piece may produce changes in apparent declination and ascension. With given adjustments these errors will be constant, and do not practically interfere with equatorial *finding*.

We find a Barlow lens and lower eye-pieces, as a rule, better than deeper eye-pieces without it, and upon planets and delicate moon objects we prefer Mr. Browning's achromatic eye-pieces to the Huyghenian. A monster aplanatic of Horne and Thornthwaite works well with the Barlow on nebulæ or clusters, and on many large objects usefully without it.

Duly balancing advantages and disadvantages, we feel satisfied that the silvered mirror telescopes will prove an immense boon to astronomical observers. They bring within the reach of amateurs with moderate means, an amount of optical power and a perfection of optical work hitherto confined to a few first-class observatories; and if fine prisms are used

instead of silvered flats, no fault will be found with the colour of the objects viewed. A slightly tarnished flat, exaggerating the peculiar chromatic action of the silver film, gives an unpleasant reddening to white objects; a fine prism is quite satisfactory, but it must really be a fine one, for *very slight* errors in its planes, and especially in the plane of the hypotheneuse, will render good definition impossible.

Mr. Browning's pamphlet, *A Plea for Reflectors*, contains a mass of valuable information, which we commend to those in need of it.

CHEMICAL AIDS TO ART.

BY PROFESSOR A. H. CHURCH, M.A., F.C.S.,

Of the Royal Agricultural College, Cirencester.

Some of the recent applications of chemistry to the fine arts are so full of interest, and yet so little known in scientific and literary circles, that a brief description and explanation of them is sure to prove instructive and entertaining to many of the readers of the Intellectual Observer. The subject is, indeed, very extensive, and on this account we propose, in the present paper, to limit the discussion to a few processes connected with the ornamental and artistic use of metals. We shall select three processes, all comparatively of recent invention; of none of them, so far as we are aware, has any account been hitherto published. They, moreover, have the advantage of being easily illustrated in home-made experiments, by any of our readers who care to follow the instructions about to be given.

Let us begin with platinum, one of the least known of the "precious" metals. Precious it is for several reasons. Not that it is very beautiful in colour and lustre, for although it may be obtained nearly as white as silver, its appearance usually resembles that of pewter very closely; yet time and experiment have shown that it has most valuable properties. It never tarnishes, no ordinary flame, or fire, or furnace will melt it, most strong acids and many chemical salts do not dissolve or injure it; and, when you do get it to dissolve, its solution forms a most useful chemical test, or "reagent," as it is called. Since the year 1741, when platinum was first brought to Europe, under the name of platina, or "little silver," it has been employed for many different purposes. As it could not be worked like ordinary metals, the Russians,

who made coins of it, adopting the plan invented by the English chemist, Wollaston, submitted the powder of platinum, as obtained by the chemical treatment of the ore, to powerful pressure, and to repeated blows, and also to the influence of a very high temperature. By this process the powder or fine particles of the metal may be made to cohere into an uniform solid mass. It is thus that platinum is fashioned into crucibles for chemists, stills for the purification of sulphuric acid, foil, leaf, and wire for various useful purposes. But we really must not dwell further upon these interesting facts in the history of platinum, for our intention is to describe something newer and less known. We purpose giving the details of a very simple and beautiful process for covering other metals with a delicate film of metallic platinum, and so at once varying their appearance, and endowing them with one of the virtues of this metal, namely, incorrodibility.

We have before mentioned that although platinum does not easily dissolve in acids, it can be induced to dissolve by appropriate treatment. If a few grains of scrap platinum, which may be purchased at the rate of about twenty shillings the ounce, be warmed in a flask with a mixture of three parts of hydrochloric (muriatic) acid and one part of nitric acid (aqua regia), it will soon begin to disappear, dissolving in the acids with a red-brown colour, not unlike that of dark sherry. This liquid contains a compound of the metal platinum with the non-metallic element chlorine. This compound is generally called bichloride of platinum. It may be obtained in the solid form by drying up, at a gentle heat, the acid solution of the platinum scrap. This salt or compound of platinum, may be thus prepared—40 grains of the metal yielding about 68 grains of the bichloride; or it may be purchased at a very moderate price. It cannot, however, be used directly and without any further treatment for the purpose we have in view, namely, the plating (or, rather, platinizing) of various metals. The following directions will serve for the preparation of a suitable solution for this purpose:—Dissolve in one ounce of distilled water—

60 grains of bichloride of platinum and
60 grains of pure honey.

Add to the above solution three quarters of an ounce of spirit of wine, and one quarter of an ounce of ether. The mixed liquids, if not quite clear, must be filtered through a piece of white blotting-paper. The objects to be platinized, which may be of iron, steel, copper, bronze, or brass, are to be thoroughly cleaned by washing them in soda, then in water.

When they have been dried, they require heating over a lamp, to a heat below redness. For this purpose they may be suspended, by means of a fine wire, over a spirit or an oil lamp, in such a way as not to touch the flame. Suddenly, before they have had time to cool, the objects are to be completely plunged beneath the surface of the platinizing liquid. One immersion for a single minute generally suffices; but the process may be repeated if necessary, care being taken to wash and dry the pieces operated upon before re-heating them. The composition of the solution may vary considerably, and yet good results be obtained. Sometimes the addition of more honey improves it; sometimes the proportion of bichloride of platinum may be increased or diminished with advantage. Indeed, it will be found that the appearance of the platinum film deposited upon the objects may be altered by changing the proportion of the bichloride present. The solution may be used several times; gradually, however, it loses all its platinum, the place of this element being taken by the iron or copper dissolved off the immersed objects.

We may now appropriately mention a few examples where this platinizing process seems to furnish desirable results. Articles made of iron or steel—watch-chains, seals, sword-handles, keys, and similar useful or ornamental objects—are greatly improved in appearance, and, moreover, preserved from all chance of rusting, by this treatment. The colour of the platinum film is of a neutral greyish black, and it often shows at the same time a faint iridescence. Iron or steel which has been inlaid with gold or silver, forming what is known as damascened work, is greatly improved by platinizing. Neither the gold nor the silver are in the least degree affected, and they will be found to afford a better contrast with the colour of the platinized than with that of the original iron.* Other artistic applications of this process will readily suggest themselves: coins, medals, chains, and ornaments of brass and copper may be instanced as excellent subjects for experiment. If they have been partially gilt or silvered before treatment with the platinizing liquid, those parts only of the specimen which show the original metal will change in colour. In this way very beautiful and effective designs of gold on platinum,

* Iron which has become deeply rusted cannot be platinized by our process. In order, however, to preserve from further destruction objects of steel or iron having an archæological or artistic interest, a very excellent plan may be used as a substitute. The purest white paraffine is to be melted in a clean pan, and maintained at about the temperature of boiling water. The rusted and corroded specimens are to be immersed in this paraffine bath till they cease to froth from escape of moisture. They are then withdrawn, wrapped in blotting paper, and kept in a warm place till the excess of paraffine has been absorbed. The objects thus treated, while preserved from further decay, do not acquire that disagreeable greasy aspect which the varnish ordinarily used imparts.

or silver on platinum, may be formed, while in the case of gold, at all events, the groundwork metal of copper or brass would scarcely have shown an appreciable contrast of colour.

Let us now consider a second process, not altogether dissimilar to that just described, but in which silver instead of platinum is concerned. We have already referred to damascening, in which iron is inlaid with gold or silver by a purely mechanical process. The same result may, however, be attained with silver as the inlay, in a totally different manner. The hollows destined to receive the silver patterns are engraved or etched by acid in the iron or steel, but, instead of using wires of metallic silver to fill these hollows, a chemical compound of silver is employed. This compound is the nitrite of silver, and is easily prepared by adding pure nitrite of sodium, dissolved in water, to a solution of nitrate of silver. When no more precipitate falls on further additions of the nitrite of sodium solution, the pale straw-coloured substance, which is nearly pure nitrite of silver, is to be collected on a filter, a little cold water poured upon it, and then, while still moist, pressed into the grooves in the iron which have been prepared for its reception. Here it is permitted to dry, and, when it is perfectly free from moisture, the next step in the process may be taken. This step consists in heating the metallic plate or other object over a lamp or fire till the whole of the nitrous acid has been resolved into gases, which escape, and metallic silver, which is left behind as a spongy mass. With an agate or steel burnisher the whole of the lines of silver must be followed, using considerable pressure to force the metal into the grooves and lines, any superfluous silver being rubbed away with very fine emery-powder, or a fine pencil-like hone.

Many metals besides iron may be ornamented with beautiful designs in inlaid silver by means of the process just described. Among these may be named copper, brass, and bronze; even gold and platinum admit of similar treatment. In all cases an easy method of etching out the hollows of the design is applicable. Both sides of the plate to be inlaid are covered with a resisting composition (beeswax melted with a little spirits of turpentine), the designs are boldly drawn, so as to lay bare the metal, and then the prepared object is to be immersed in the etching fluid. Weak nitric acid answers for all the common metals we have before named. When the design has been etched to a sufficient depth the object is withdrawn from the acid, and (after removal of the composition by means of spirits of turpentine) passed through the flame of a spirit-lamp, to burn off the last traces of the wax and turpentine.

This new process of inlaying silver no doubt requires some

practice before it can be accomplished with perfect success, and it probably admits of improvement. It has the advantage of great durability; it is applicable to a great variety of objects and materials, while the silver employed is of the utmost purity and beauty.

It may interest our readers to know how this process originated. The author of the present paper had occasion to illustrate in a lecture the readiness with which many salts of silver are decomposed by heat. For this purpose some nitrite of silver was placed on the blade of a penknife and heated over the spirit-lamp; the residue of silver left on the blade was afterwards found to be so firmly attached to the blade that it required to be filed away. This accidental observation led to further experiments, the final result of which was the process we have now described.

Metals are occasionally inlaid with coloured pigments and with enamels. True enamelling on inferior metals, such as bronze, brass, and copper, is not, however, now often practised, and we have to be content with the inferior substitutes for it which oil colours and different kinds of sealing-wax afford, for of such materials consist the so-called enamelled ornament which we often see on the otherwise excellent mediæval brass work so abundantly manufactured at the present day. A hard and purely mineral substitute for these oil paints and coloured preparations of shellac has long been a desideratum. The process now to be described, although far from perfect, is capable of affording some admirable artistic effects. The materials employed have been used for some years by dentists as a white stopping for teeth. Exactly in the same way they may be used as an inlay for almost any material in which grooves, channels, or hollows have been previously cut. This dental preparation goes under the name of "osteo-plastic" and "os-artificiel." It is made of oxide of zinc, worked into a paste with a strong solution of chloride of zinc; these two zinc compounds chemically combine together, heat is given out, and in a few minutes a hard, dense, insoluble white mass is formed, which, when properly prepared, is almost indestructible. The dental os-artificiel generally contains about 10 per cent. of quartz powder, added to increase the hardness of the composition; but, in using the oxychloride of zinc for decorative purposes, this addition is unnecessary, while the admixture of various dry powdered colours, on the other hand, greatly enhances and diversifies the effects producible. The following mineral pigments may be used in the proportion of one part of pigment to nine of oxide of zinc: vermilion, oxide of chromium, cadmium yellow and cobalt blue. The oxide of zinc must be very pure and very

dense.* It is to be made into a stiff paste with water, and then introduced into those hollows of the metal-work which are to be thus decorated. When the paste has become dry the excess is to be removed with a cloth, and then the lines which have been filled up are to be carefully painted over with a strong solution of chloride of zinc. For this purpose a saturated solution, diluted with its own bulk of water, may be used. In ten minutes the composition sets, but it continues to become harder and harder for several days. Where coloured instead of white inlays are required, exactly the same directions are to be followed, the oxide of zinc being, however, carefully mixed with the necessary colours in powder before the composition is moistened with water. In all cases the operation succeeds best when the materials are warm; it is a great improvement to use the chloride of zinc solution hot. Before the oxychloride of zinc sets its surface may be polished with a piece of smooth box wood. For small objects the oxide of zinc may be mixed with the chloride, and the paste at once introduced, but for large objects the paste hardens before the work is finished.

The three processes we have described admit of many variations in practice, variations by which they may be adapted to different forms, designs, and materials.

A RAMBLE IN WEST SHROPSHIRE.

BY THE REV. J. D. LA TOUCHE.

The hilly tract of country which lies to the west of Shropshire has probably been less explored than it deserves. Except to the huntsman, whose earnest pursuit of his favourite sport sometimes carries him into it, or an enterprising geologist resolved to "rough it" at the wayside "publics," which are here few and far between, it has of late years been known to few besides those who actually reside in it. Of late years, I say, for there are abundant evidences that in earlier times it was the scene of a busy and enterprizing population. The mineral wealth with which it abounds having attracted the notice of the Romans, and traces exist of their industry, both in ancient works for the manufacture of lead, and the villas in which they lived. Being, however, considerably out of the highroad of traffic, and separated by the Longmynd, a tract of high land running north and south for upwards of 15 miles, from

* Winsor and Newton's condensed zinc white answers well.

the rest of the country, it is not surprising that its real merits have been so much overlooked. Now, however, that even the solitude of this remote region is penetrated by the railway, and it is thus accessible to the civilized world, it may be not unacceptable to those who, in their summer rambles, prefer diverging from the well-worn track of the ordinary tourist, to be informed of a few of the objects of interest to be found there.

The most interesting feature in this neighbourhood is its geology. It is here possible to trace the history of some of the earliest rocks which form the earth's crust. The traveller by rail from Shrewsbury to Hereford will observe on his right, in proceeding southwards from the former to the latter place, a range of hills, at first low and undulating, but at last becoming a very picturesque and lofty tableland, with steep almost precipitous sides. This is the Longmynd (long mount), and has hitherto been reckoned the earliest water-formed stratum of rock in England; not, however, the earliest known at all, since there is reason to believe that rocks of the same age as these repose on still earlier, the so-called Laurentian, at Sutherland, and there is even a suspicion that a similar fact may be observed in the neighbourhood of Malvern. However, here we see those ancient rocks—the lowest leaves in a book—the aggregate thickness of which, in England alone, is computed, by Professor Ramsay, to be some 14 miles, though even this statement by no means expresses the vastness of the deposits which make up the entire geological volume; there being several breaks in the record—blanks in time, during which, from various reasons, no deposits were made, or those which had existed before were swept away.

This range of hills attains its greatest altitude near the extremely picturesque village of Church Stretton (so called from being a *town* on the ancient Roman *street* which ran through or close to it). A walk from this place westwards, through the deep glens which intersect the hills, shows us at many spots the highly inclined strata of the rock, and it is possible to trace the same up the steep smooth sides of the hills, wherever a course of sandstone, harder than the shale with which it alternates, has resisted the action of the weather, and forms a ridge.

The almost vertical position of these strata, wherever they can be examined for a distance of five or six miles, has enabled Professor Ramsay to compute their thickness at no less than 26,000 feet. The lower beds are much contorted by pressure of a peculiar kind, the layers of strata being puckered in ridges in such a way as to suggest that they have been submitted to an action similar to that which sometimes creases up the

leaves of a book, when, by some accident, pressure is applied to them along their edges, in which case the restraint above and below them, it may easily be understood, would compel them to assume this waved appearance. I have seen a similar, but very much more extensive instance of this curious phenomenon over a great portion of the country between Bray and Wicklow, in Ireland, and, the strata there, being closely allied to these of the Longmynd, it is interesting to find the same physical conditions accompanying them.

But we must hasten through this enormous mass of strata to visit a deposit of much interest which occurs near their top, on the western aspect of the hills; nor will the collection of fossils delay us much in our walk, since they are only remarkable by their absence, so that, except the tracks of worms, and pieces of stone covered with little pits, supposed to be the indentation of rain drops on soft mud, and the ripple marks of primeval tides, there is little which the most ardent collector will care to carry away from this barren tract; and yet these traces of ancient atmospheric action, and even these worm-tracks cannot but furnish to any thinking mind abundance of food for meditation. We here see proof that this vast deposit was formed under the conditions of a constantly sinking shore, whose surface was left dry after each tide swept over it—here, as to-day, the sun shone, and caused these cracks, the wind blew, and so these ripple marks were formed; then, as now, over those dreary wastes the showers of heaven fell, and a worm similar in its mode of progression to that which is to this day found on our coasts, crawled along its surface. How much could we desire to know whether other animals of a higher organization existed at the same time? Where, too, were the vast tracts of continent which supplied the materials for these rocks? Such questions as these will probably remain very long unanswered. It is to be remembered that in geological strata we have only the records of those conditions which exist under water, and that, in but very rare instances, is there any reason to expect the preservation of specimens of land growth.

The next deposit to which I would direct attention is the conglomerate, which is found along the western slopes of the Longmynd, and which seems to have had, at least in this locality, a very extensive range, as it is also found near Shrewsbury, at Sharpstone Hill, and elsewhere. This deposit furnishes us with some specimens, at least, of still more ancient rocks, water-worn and glued together in a vast mass. The study of these conglomerates, where they occur, is very interesting, since they disclose not only the nature of some of the pre-existing rocks, but even may indicate, to some

extent, the configuration of the land where they were deposited. Similar deposits are occurring at the present day, and give us a clue to the conditions under which these early ones were formed. Reasoning thus, we may conclude, when we find a conglomerate, that we are in the immediate neighbourhood of some ancient sea beach or estuary, or that this was the site of some vast river or mighty current; stones such as those which are found in it, are never carried out to any great distance from the land. In this conglomerate, moreover, may be remarked a very striking instance of that slow but immensely powerful process by which change takes place in the very substance of the materials of which the earth's surface is composed. It is in several places traversed by veins of quartz running right across the strata in direct lines, so as to traverse even the substance of the pebbles which lie in their way. It is easy to conceive a crack occurring in a solid rock, and to suppose quartz infiltrated therein, but such a supposition cannot be admitted here, there is no appearance whatever of any fissure by which these pebbles could have been divided, and yet, where they lie in the course of the line of quartz formation, a portion of their substance has become quartz. It is clear that here we perceive evidences of a kind of chemical action taking place in a certain plane, and suggests to us that, on a larger scale, the same may account for many of those effects which have been too frequently ascribed to igneous and volcanic action, in default of any known cause, just as it is the custom, among those who are quite ignorant of the laws of electricity, to attribute to it every unaccountable phenomenon.

But it is time for us to wend our way westwards to the Stiperstone range—hills of considerable height running parallel with the Longmynd. This ridge is considered, by Sir R. Murchison, to be the representative of the Lingula flags of North Wales, and the lowest member of the Silurian group. Its most marked physical feature is the existence at intervals along its summit, for a distance of ten miles, of huge masses of rock protruding from the surface to the height of twenty or thirty feet. These rocks, being quartzose, and very much harder than the surrounding strata, have resisted more effectually the action of the atmosphere, to which the whole has been exposed since its emersion from the ocean, and there they stand like gigantic fortresses, grey and ribbed with age, looking down in lonely majesty on the silent, ceaseless decay of all around; adding, too, their own contributions to the general ruin, as is testified by the masses of rock torn from their sides by many a frost, and which lie beneath them on the flanks of the hill.

Sir R. Murchison has observed that there are several

bosses of greenstone in the neighbourhood of the Stiperstones, which indicate the existence in past times of great volcanic heat, and there can be little doubt that, under the influence of this, the origin of almost every physical result, a metamorphic action took place in the already deposited rocks, and, by that segregative force to which I have already alluded, some portions assumed properties distinct from the strata in close connection with them.

We now are, at last, in the region of fossils. Near the top of the Stiperstone ridge, and on the western flank, in the holes scratched by the sheep to form for themselves a little shelter in the bleak winter days, may be found fragments of trilobites and shells of very early types. Not sufficiently explored, indeed, are these deposits; but the task of doing so is difficult, both from the remoteness of their locality and the few spots at which any access can be obtained to them.

From the lofty ridge on which we now suppose the geologist to stand, he looks westward on an extensive undulating country, chiefly consisting of what is called the Llandeilo formation, and towards the south-west he sees, standing up prominently out of the lower lands around it, the hill of Corndon, a mass of greenstone or volcanic rock, representing a vast upheaval of strata in its neighbourhood, and causing a kind of V shaped arrangement of the intermediate beds, they having been raised up both along the line of the Stiperstones, on the one hand, and by the protrusion of the Corndon, on the other.

And here, for the present, we must leave our tourist contemplating a scene which has, whenever I have had the opportunity of surveying it, filled me with admiration. The wild hillsides of the Stiperstone range, covered with bog and heath, contrast well with the fertile country below; the gaunt mass of the Devil's Chair and other rocks, which at intervals rear their forms boldly out of the crest of the ridge; Corndon in the distance, once perhaps, a glowing mass; and, according to Sir R. Murchison, volcanoes in full activity once reared their peaks above the waters which covered the earth when these enormous strata were being deposited. The evidences of such mighty operations of nature, the cinders of the vast forge in which the earth's crust has been moulded, may well impress us with a sense of the powers which are in ceaseless action round us, and which have from all eternity, and will to all eternity, evolve the purposes of the Creator.

RUMINATION IN FISH; THE SCARUS OF THE ANCIENTS.

BY REV. W. HOUGHTON, M.A., F.L.S.

Rumination, or the power possessed by certain animals of casting up small portions of food from the stomach into the mouth for the purpose of re-mastication, is amongst mammalia normally confined to the ruminant order, comprising the families *Camelidæ*, *Moschidæ*, *Camelopardidæ*, and *Bovidæ*, including the antelopes, sheep, and cattle. I say *normally*, because, as is well known, certain individuals of the genus *homo* have been known to possess this power.* Moreover, Professor Owen has, I believe, observed a quasi-ruminant power in some species of kangaroos. It is possible that careful observation may discover occasional instances of abnormal rumination in other orders; in most of the mammalia there is nothing to prevent the regurgitation of food from the stomach into the mouth for re-mastication, but in some there is a mechanical obstruction, as for instance in the horse, the valvular construction of the entry of whose stomach renders such an act impossible. It appears, however, from the investigations of Professor Owen, that rumination is not confined to the mammalia alone. Certain families of the class *Pisces* possess a power essentially identical with rumination.

"The muscular action of a fish's stomach," says our great anatomist, "consists of vermicular contractions, creeping slowly in continuous succession from the cardia to the pylorus, and impressing a twofold gyratory motion on the contents; so that, while some portions are proceeding to the pylorus, other portions are returning towards the cardia. More direct constrictive and dilative movements occur, with intervals of repose, at both the orifices, the vital contraction being antagonized by pressure from within. The pylorus has the power, very evidently, of controlling that pressure, and only portions of completely comminuted and digested food (chyme) are permitted to pass into the intestine. The cardiac orifice appears to have less control over the contents of the stomach; coarser portions of the food from time to time return into the œsophagus, and are brought again within the sphere of the pharyngeal jaws, and subjected to their masticatory and comminuting operations. The fishes which afford the best evidence of this ruminating action

* A friend of mine when studying in Germany told me of a case of rumination in the school he attended. One of the boys possessed this very undesirable accomplishment, and in consequence of his persisting in the habit in spite of all remonstrances, he was obliged to leave the school.

are the Cyprinoids (carp, tench, bream), caught after they have fed voraciously on ground-bait previously laid in their feeding-haunts to insure the angler good sport."

It is curious to observe that Aristotle, many hundred years ago, recorded the existence of a ruminating fish. "The fish known by the name of scarus," he says, "is the only one which appears to ruminate like quadrupeds." What the scarus probably denotes I shall consider by and by. The idea of a ruminating fish appeared to the commentators so absurd that they put down the statement of Aristotle as a simple myth; and even Mr. G. H. Lewes, in one of his instructive works,* citing this amongst Aristotle's "examples of careless observation and rash generalization," utterly discredits the possession of ruminating properties in a fish. He says, "If true, the fact must be one difficult of observation, since fish will not exhibit their ruminating propensities out of the water, and *in* the water it could hardly have been watched. Is it true?" In a foot note, Mr. Lewes adds, "Milne Edwards states it without misgiving in his *Leçons sur la Physiologie et l'Anat, comparée*, 1861, vi. 290, referring to Owen's *Lectures on the Vertebrata* as his authority. In a private note, Professor Owen informs me that the *Scarus* named by Aristotle has not been identified, but that 'the carp, by a rotatory motion of the gullet, brings the vegetable food-contents of the stomach successively within the sphere of the action of the strong pharyngeal grinding teeth, whence the pulp is returned to the stomach fitted for passing the pylorus'" (pp. 282, 283). Now we naturally wish to ascertain how Professor Owen has convinced himself of this fact, which at first sight appears difficult of verification. The professor tells us, "A carp in this predicament [after having fed voraciously on ground-bait] laid open, shows well and long the peristaltic movements of the alimentary canal; and the successive regurgitations of the gastric contents produce actions of the pharyngeal jaws as the half-bruised grains came into contact with them, and excite the singular tumefaction and subsidence of the irritable palate, as portions of the regurgitated food are pressed upon it. The shortness and width of the œsophagus, the masticatory mechanism at its commencement, and its direct terminal continuation with the cardiac portion of the stomach, relate to the combination of an act analogous to rumination, with the ordinary processes of digestion, in all fishes possessing these concatenated and peculiar structures."†

In a communication with which he has kindly favoured

* *Aristotle, a Chapter from the History of Science.* London: Smith, Elder, and Co. 1864.

† *The Anatomy of Vertebrates*, vol. i. p. 419.

me, Professor Owen makes the following further interesting remarks, "Continued observations, under the rare and difficult circumstances according to which they can be made, have now convinced me that matters for mastication by throat-chewers come *from behind*, as those by mouth-chewers *from before*. And indeed when one came to consider how thoroughly and regularly the mouth of a fish is washed out by the branchial streams, there needs must be some special arrangement for the masticating machinery in lithophagous and phytophagous fishes. Consider what would be the consequence to the partially broken up coral and pulp if retained at the back of the mouth to be pounded piecemeal by the pharyngeals, the rush of two diverging streams through that faucial area going on the while like clockwork. No! the food reduced if needful to a size swallowable, is bolted, and the branchial way speedily cleared. Then comes into play that anti-peristaltic rotation of the short gullet, and bit by bit the contents are shed in *a tergo* between the grinders till all is pulped." I have lately had an opportunity of examining a carp, but the whole intestinal tract was perfectly empty. This is probably the case with the *Cyprinidæ* generally during the cold months. We must wait for warm summer weather when we may be rewarded by witnessing what Professor Owen has so minutely described, There are good figures of the throat-teeth of the carp, tench, roach, and barbel, in Yarrell's *British Fishes*. (Introd. p. xx.) The worn appearance of the crowns of these teeth in the carp are very striking, being, as Yarrell says, like "the molar teeth in the hare." Besides the pair of pharyngeal jaws, there is, in the carp and tench, a single occipital tooth, situated between the pharyngeal pair, and upon which, as upon an anvil, these last-named teeth appear to work.

With regard to the fish known to the ancients by the name of *Scarus*, although positive specific identification is certainly not warranted by the accounts given of it, yet there is some evidence in favour of its being a species of scarus still found in the localities assigned to it in the writings of the ancients. According to Aristotle, the scarus is remarkable for the form of its teeth; it differs from all other fish in not having pointed or shark-like teeth (*καρχαρόδοντες*), though Aristotle does not tell us what sort of teeth it had. Its food consists of sea-weed. He alludes to its ruminating propensities in two places; and the story descends, being narrated by Œlian, Athenæus, Ovid, Pliny, and others. According to Horapollo (ii. 109), the ancient Egyptians delineated a scarus when they wished to symbolize a man given to gluttony, "for this fish is the only fish which ruminates and eats all the little fishes which fall in its way." Oppian speaks of the scarus frequenting rocks

covered with sea-weed, and assigns to it the possession of a voice :—

"Here scaros feed, the only kinds that dare
To form shrill sounds, and strike the trembling air.
To pensive silence doom'd, no other fish
Can speak his wants, or tell his secret wish;
Thrice o'er their food the wanton scaros eat,
With pleasure the luxurious toil repeat,
Like sheep in grassy meads, or fat'ning kine,
They chew the cud, and on the taste refine."*

Amongst other of the varied accomplishments attributed to the scarus may be mentioned the mode by which it would rescue one of its captive friends, as it lay confined in the weel trap. The scarus would insert its tail between the twigs, and the prisoner would seize it with its teeth, and so be dragged out by main force, the captive firmly holding in his mouth the liberator's caudal appendage! From Horace and Martial we learn that the scarus was a favourite and dainty dish; the latter speaks of its being only good when cooked with its intestines :—

"Hic scarus, aequoreis qui venit obesus abundis,
Visceribus bonus est; cætera vile sapit" (xiii., 84).

Similarly Athenæus (*Deipnosoph*, vii., 113), quoting Epicharmus—

"We fish for spari, and for scari too,
Whose very dung may not be thrown away."

Archestratus, in his recommendations as to the best mode of cooking scari, refers to the form of the fish in the following line :—

καὶ μέγεθος κυκλίᾳ ἴσον ἀσπίδι νῶτα φοροῦντα.

"With back as broad as a large round shield,"

a description quite applicable to some of the scari.

Pliny says of this fish :—"At the present day, the first place is givin to the Scarus, the only fish said to ruminate and to feed on grass, and not on other fish. It is mostly found in the Carpathian Sea, and never of its own accord passes Lectum, a promontory of Troas. Optatus Elipertius, the commander of the fleet under the Emperor Claudius, had this fish brought from that locality, and dispersed in various places of the coast between Ostia and the districts of Campania. During five years the greatest care was taken that those which were caught

* *Halieutics* I., 215—222. Draper's translation. Oppian's own words are very clear and expressive :—

καὶ μοῦνος ἐδητὺν
δψορφον προίησιν ἀνὰ στόμα, δεύτερον ἄντις
δαινύμενος, μήλοισιν ἀναστύσσων ἴσα φορβήν.

should be returned to the sea, but since then they have been always found in great abundance off the shores of Italy, where formerly there were none to be taken" (ix., 30). The scarus was of various hues (*ποικίλον*). Nicander says there are two kinds of scari—one was called *ὀνίας*, the other *αἰόλος*, "with changeful hues."* Now it happens that a species of scarus of modern ichthyologists is still found in the Carpathian and Ægean Seas; it was noticed by Spratt and Forbes, who thus speak of it:—"Another fish frequently mentioned by ancient writers is the scarus; it was supposed to ruminate its food, a fancy to which the peculiar aspect of its teeth may have given rise. This was, doubtless, the *Scarus cretius* of modern ichthyologists, a fish abundant on the Lycian shores, and still called by its ancient name. It is remarkable for the variations of colour it presents at different seasons; at one time being of the most livid crimson, at another of a dull bluish-grey, and sometimes piebald of the two colours" (*Travels in Lycia*, ii., 86).

Aldrovandus identifies the ancient scarus with a fish he calls *Scarus cretensis*, and Cuvier says, "The Archipelago contains one species, of a blue or red colour according to the season, which is the *Scarus creticus* of Aldrovandus, and which, after new investigations, I believe is the true scarus so celebrated among the ancients. It is still eaten in Greece, and its intestines are used for seasoning" (*Animal Kingdom*, p. 311, edition Carpenter and Westwood). Now the structure of the jaws in the genus *Scarus*, which has given the name of "parrot-fish" to the different species comprised in it, is very remarkable; and if the ancient scarus is identical with the scarus of modern naturalists, it is strange that, amongst the numerous notices of the scarus in classical authors, there is nothing like a description of its teeth, nor, indeed, is there any clue at all that would be sufficient to enable us to speak with certainty about its identification. The sharp, parrot-faced mouth of the modern scarus is used by the fish for the purpose of biting off the stony corallines, nullepores, etc., which form the chief proportion of its food.† As Professor Owen has said, its mouth "is peculiarly adapted to the habits and exi-

* *ὀνίας* is derived from *ὄνος* "an ass," and is applied to the scarus on account of its grey colour. There is little doubt that both *αἰόλος* and *ὀνίας* denote the same fish according to its colour at different seasons, *ὀνίας* being well represented by the "dull bluish-grey" of Spratt and Forbes.

† The teeth of the scarus are figured in Professor Owen's *Anatomy of Vertebrates*, vol. i.; also in the *Odontography* of the same author, and in the *Cyclopedia of Anatomy and Physiology* by Todd and Bowman (Art. Teeth). Professor Owen draws attention to the close analogy between the dental mass of the scarus, and the complicated grinders of the elephant, both in form, structure, and in the reproduction of the component denticles in horizontal succession. *Anatomy of Vertebrates*, vol. i., p. 381.

gencies of a tribe of fishes which browse upon the lithophytes that clothe, as with a richly-tinted carpet, the bottom of the sea, just as the ruminant quadrupeds crop the herbage of the dry land." In another place he says, "the proof of the efficacy of the complex masticatory apparatus is afforded by the contents of the alimentary canal of the scari. The intestines are usually laden with a chalky pulp, to which the coral dwellings have been reduced." Now corallines, in the time of Aristotle, were regarded as sea plants, and might well enough be intended by Aristotle's *φυκίον*. But what led the Stagirite to believe that the scarus ruminated, when he denies the power to all other fish, although certain species of *Cyprinidæ* were known to him? Was he acquainted with the pharyngeal teeth of the scarus? Probably he was only repeating, as he often did, a hearsay story; and the peculiar beak-like jaws of the scarus may have suggested to some Greek fisherman the idea that it ruminated. It is probable that the scarus, like the *Cyprinidæ*, returns portions of the hard coralline contents of its stomach for trituration by the masticatory pharyngeal teeth; but the ancient idea, if a fact, was not the result of a scientific investigation or observation, but simply a happy guess.

LUNAR DELINEATION.—THE LUNAR ARISTILLUS AND AUTOLYCUS.

BY THE REV. T. W. WEBB, M.A., F.R.A.S.

Some remarks were made, in our last number, on the expediency of forming a monograph of the lunar spot *Cassini*, by means of a series of sketches taken under very varied angles of illumination. Nothing less than this is in fact demanded for every accessible part of the visible hemisphere of our satellite, before our knowledge of her surface can be considered commensurate with the progress of modern astronomy. We have here evidently an undertaking involving the employment of many eyes and hands, and extending, especially in our turbid climate, over many seasons; and as it lies somewhat on one side of the province of the regular observatory, so fortunately it is one in which amateurs may render very efficient aid. This indeed is being done to some extent at the present moment; but a considerable increase may be looked for in the number of such observers, both from the attention which the subject has attracted of late years, and from the far greater

ease with which adequate optical aid is now attainable. All of these cannot be expected to bring to their task a full knowledge of the peculiarities of lunar delineation, a subject which in fact has been hitherto little explained; and to those less skilled in such matters the following remarks may be of use.

The time in lunar drawing is long gone by when "anything would do," or when pictorial effect could be substituted for painstaking accuracy. What is now wanted is nothing less than fidelity in outline, and fulness in detail. For this purpose, some artistic training is highly desirable. It is to be regretted that a fair portion of skill in design is not required of every person pretending to a liberal education; the advantages and the gratification arising from it would be found matters of almost daily experience, and to the possessors of telescopes it would be of especial value. Any one who has been accustomed to sketch frequently from nature, and who knows how wonderfully varying are the effects of light and shade on the same object at different times of the day and seasons of the year, and from even slightly varied points of view, and how details, which under some circumstances are not only perceptible but prominent, vanish under an altered relief of the surface, will find little difficulty in making or interpreting drawings of our satellite.

To others all this is less easy, but let them persevere; they will (or ought to) master the subject in the end, and with much interest by the way. Success, however, can scarcely be expected, unless due precautions are attended to, and the ordinary rules of drawing observed. Students should be content with advancing from simpler to more complex forms, and, instead of filling in outlines with a number of unmeaning scratches and careless shadows, endeavour first to master thoroughly the nature of what they see, and then to give to every stroke and shading its due significance in representing it. Such drawings alone can be really satisfactory to the designer, or worthy of preservation.

It is of consequence that too large an area (however full of interest) should not be attempted at once. Much time would be wasted in getting correctness of general position, which, after all, would be best left to the micrometric or photographic observer; and those details which in the present state of selenography are far more valuable, would be hurried over, if not in part omitted. And besides this, even if a long night during the high reign of a winter's moon were selected for a large design, the shadows near the terminator would be found, in the course of a few hours, to have materially altered in length. It is better on every account to content ourselves with well-worked studies of circumscribed areas. Many such might be

satisfactorily obtained in the time wasted in some extensive and disappointing attempt.

Having chosen a region suitable for our purpose, we ought obviously to sketch it under many varying angles of incident light—soon after the lunar sunrise, more than once during the advancing morning, at midday, and several times as the afternoon declines, and towards sunset. This, however, partly from weather, partly from the fact that the moon is not always in an observable position at the required epoch, could not be accomplished in a single lunation. Our whole series of studies of any one spot must inevitably be made up of sketches taken during different monthly periods, and perhaps after considerable intervals; and we must be prepared for discrepancies arising from this cause. We may notice a slight difference in the direction of the illumination, and, excepting near the centre of the disc, the perspective foreshortening and relative bearing, or what may be termed *allineation*, may be somewhat altered; and this may be accompanied with a change in the visibility of minute details. Hence we shall feel inclined to multiply our sketches, and to institute comparisons between such as bear a general resemblance; and thus we shall materially enlarge our knowledge of the true nature of the surface. In order, however, to avoid mistake, the following considerations must be borne in mind.

Whatever similarity may exist at first sight, no strict comparison can take place between any two sketches in which the angles of illumination and vision are materially unlike. If, indeed, the representations taken under such different circumstances should be found to agree, one great point is gained: we ascertain not only that the features are the same, but that they are not of a character to vary much in appearance from such causes. If, on the other hand, there should be much discordance, we are still a long way from any safe inference as to physical change. For while the angles of incident light may be indefinitely varied, and frequently with little apparent effect on the aspect of objects, there are cases in which a very slight difference in the sun's altitude or azimuth would replace brightness by a half-tone, or even a black shadow; and so again a varied angle of vision, even if it does not, as may often happen, affect the brightness of the surface more directly, may influence our view of it materially by exposing or concealing portions in light or shade. Either of these causes therefore, or both conjointly, may account for much apparent incongruity of representation. If the moon revolved around us in a circular orbit, in the plane of the ecliptic, and with an axis perpendicular to that plane, neither of these sources of discrepancy would exist, but every portion of the surface would be illumi-

nated and viewed under precisely the same angle at the corresponding hour in every successive lunation; and in that case any apparent would certainly indicate a corresponding physical alteration. But since none of these three conditions of identity are fulfilled, variations of aspect, especially among the minuter details, are of continual occurrence. And while these doubtless enable us to become better acquainted with the character of some objects, as a countenance is better understood under slight differences of position, than when gazed at in the unvaried fixity of a portrait, still all such accidental causes of variation have to be allowed for, and, as far as possible, eliminated, before we can pronounce upon the probability of physical change.

In order then to be able to compare with rigorous accuracy any two drawings of the same lunar object, presenting general similarity with difference in detail, it would be necessary to ascertain by calculation the altitude and azimuth both of the sun and of the eye of the observer, as viewed from the spot in question, at the epoch of observation, and this would involve a number of troublesome computations. But, fortunately, for general purposes the end may be sufficiently attained, in most cases, in a much simpler way. First, we have to consider the conditions of illumination, as to vertical angle and lateral direction. The vertical angle depends upon the distance from the terminator, that distance being equal to the altitude of the sun at the place. It will be sufficient therefore for our purpose if we record the position of the terminator as regards some conspicuous feature near the observed region, specifying for instance that it bisects the ring of a known crater, or that one-third, or three-quarters of the ring are enlightened, or that its summit is just touched by the sun in the night-side, or that it has advanced by its own diameter, or so many parts of its own diameter, within the boundary line. This degree of accuracy will in general be quite sufficient to ascertain the vertical angle of illumination, or elevation of the sun above the horizon of the feature we are observing. But the lateral direction of the illumination has also to be attended to; in other words, the azimuth, as well as altitude of the sun, as viewed from the lunar spot. For though it is the difference of seasons upon the earth that causes the sun to have such widely different bearings by compass at equal altitudes at different times of our year; and though, in a popular sense, it may be said that the moon has no seasons, yet this is not strictly true. It would be so if she revolved in the plane of the ecliptic, on an axis at right angles to that plane, for then the sun would rise and set on the same point of the lunar compass throughout the lunar year. But her axis is not perpendicular to her orbit (nor

to the ecliptic), being inclined to it at an angle of 1° 28′ 47″.* Hence results a continuous and systematic change, analogous to that of the terrestrial seasons, only as inferior in extent as the angle 1° 28′ 47″ is to 23° 27½′ (the inclination of the earth's axis). And consequently each pole of the moon is in light or darkness by turns; and the horns are constantly approaching, coinciding with, or departing from, the polar points; and the "line of the horns," that is, the chord of the whole terminator, or the terminator itself when it is a straight line, seldom coincides with a lunar meridian, but intersects it at the equator in some small and constantly varying angle. The result of these changes is that, instead of rising always due E., the sun, as viewed from the moon, may sometimes rise about 1½°, or three times its own apparent breadth, N., sometimes as far S. of that point; and as, under such circumstances, a house standing due E. and W. on the earth would see the sunrise sometimes from its N., at others from its S. windows, so a line of cliffs running due E. and W. on the moon would sometimes be bright in the early morning, sometimes all in black shadow. To eliminate such apparent discrepancies, we must obtain not merely, as already specified, the distance from the terminator, that is, the sun's altitude, but also the direction of the terminator itself, which is equivalent to his azimuth. And as the former *datum* is obtained by the position of the terminator as regards some known spot as near as may be to the region we are studying, so we get the latter by noting its position in the same way with regard to two other spots, lying as far N. and S. as we can conveniently find them, from the more central one already referred to. The *distance* and *direction* of the terminator being thus ascertained, we can compare the angles of illumination at different epochs with sufficient accuracy for our present purpose.

The varying direction of vision depends upon other considerations, and two other distinct data are required—libration in longitude, and libration in latitude. The effect of the former at its maximum would be the same as if the eye of the observer were shifted to points alternately 7° 55′ E. or W. of its normal position; the latter at its maximum would in like manner transpose it alternately 6° 47′ N. or S. These two changes, involving, at least, the *possibility* of much diversity of aspect, are combined in every proportion and degree; but fortunately for amateur selenographers, their adequate expres-

* The inclination of the moon's orbit, and its continually varying direction from the motion of the nodes, have not been noticed here, because, though very conspicuous to us, they subtend so extremely small an angle, not exceeding 50″, when viewed from the distance of the sun, as to exercise no perceptible influence on the direction of the incident light.

sion is very simple and attainable. Libration in longitude may be represented by the interval of time since, or until, the nearest perigee or apogee (or both may be specified if each is distant): if these intervals do not greatly differ in the drawings to be compared, the change in the direction of aspect E. or W. can have no material effect. Libration in latitude is correlative with the latitude of the moon at the epoch of observation; and if this nearly corresponds, so does the position of the observer's eye as regards N. and S. We have only therefore to take from the *Nautical*, or *Dietrichsen's Almanac*, the date of the nearest perigee or apogee, or both, and the value of the latitude (which however ought to be *reduced* by a little calculation *to the hour of observation*), and we have all the materials for judging whether the circumstances of vision are sufficiently similar to admit of close comparison. And it will now be apparent, that if the *distance* and *direction* of the terminator, and the amount of *each* libration, are not materially different at two different epochs, then, and then only, will the corresponding drawings admit of such a rigorous comparison as not only to establish general coincidence, but to check those minute details to which astronomers are now beginning to attend.

It should, however, be borne in mind, that though the form, or position, or reflective quality of certain objects may render them, so to speak, peculiarly sensitive to slight changes in the angles of illumination and reflection (which is of course only that of vision reversed), yet in the majority of cases but little variation ensues, and that of a readily intelligible nature: and it is fortunate for selenography that it is so, since otherwise it would present a scene of such continual unsettledness as to detail as to be the source of endless perplexity and uncertainty; especially when we consider that an exact state of mean or balanced libration returns only once in three years. Schröter pointed out long ago that the ordinary changes of aspect thus arising lie within narrow bounds; and experience will soon convince us that, though we ought to be on our guard, and more than he may have sometimes been, against special cases of apparent change, yet the general aspect of things is not subject to any extensive variation, beyond that gradual transformation from light and shade to local colouring which attends the progress of the sun to the lunar meridian. As to the special cases just referred to, many such exist; some already known to astronomers, to which we shall call attention as they come before us; many more remaining yet to be studied with care, not only to acquire a minuter knowledge of the lunar surface, but to be able to pronounce more decidedly as to the truth or groundlessness of Schröter's idea, that many seeming variations indicate the

existence of an atmosphere whose denser portion does not extend much above the lower regions.

THE LUNAR ARISTILLUS AND AUTOLYCUS.

At a short distance S.W. from our last object, *Cassini*, and near the foot of the *Caucasus*, with which, however, it has no apparent connection, we shall find a smaller, but very obvious crater, *Theætetus*, so deep, that it is wholly free from shadow for about five days only during the whole lunation. The W. wall rises 7600f. above the interior, and higher still in one bright peak: the E. side is 3500f. above the plain; Schr. had given 3300f.—a close agreement. The latter made the depth 10,000f. From the data of B. and M., Schmidt found the ratio of the outer and inner heights of the wall as 1 to 2·6, and the depth $\frac{1}{13}$ of the diameter, this latter being a not unusual proportion in craters of between 12,000f. and 19,000f. in breadth. The character, therefore, of extreme relative depth—the goblet-like impression—which might be easily received in such cases from the appearance of the shadow near the terminator, is thus shown to be somewhat deceptive when checked by actual measurement. But though our lunar cups may thus be said to be turned into saucers, enough remains in their proportions to fill us with astonishment.

A double ridge rising only some 100f., and throwing off four parallel branches to the S.W., leads from *Theætetus* towards *Aristillus* (21), a crater from its size, depth, and position, belonging to the most striking class. The mass of wall, enormous in itself, but still more impressive as the result of eruptive action, though less lofty N. and S., rises W. nearly to 8900f., and with a steeper peak to fully 11,000f., the height of the great Pyrenean Maladetta, (the latter measured, however, from the sea, and producing, therefore, a less imposing effect). Schr. gives the E. side 6750f. above the surrounding *Palus*, the depth 9400f. A formation here lies beneath our eye, to which nothing terrestrial makes more than a very distant approach. What would be our feelings if transported to the midst of this huge cavity, and gazing upon its colossal boundary at a distance of seventeen miles on every side! The central hill on which we should have to take our stand is a commanding one, and of a complex character, which has not been well exhibited in the published designs. It really consists, as I found, 1861, Dec. 10, with 5½ inches of aperture, and power 170, of three parallel ridges separated by narrow ravines, rising towards S.W., and terminated, especially the outer ones, by bluffs at that end. The S.E. ridge, which is the longest, is

also enlarged at the opposite extremity; and as they progressively and rapidly decrease in length, the whole mass approaches to a triangular form. The most remarkable feature, however, connected with *Aristillus*, is the system of radiating ridges, which extend in all directions, especially S., for a distance of ten, twenty, or even thirty miles from the foot of the ring. These were discovered by Schr. in 1796, who describes them as an "innumerable multitude of little, very flat, low hills, for the most part connected and forming longish ridges, which have collectively received their general direction from the centre of the crater." This remarkable arrangement is not a difficult object, but must of course be looked for under a low illumination. I have seen it extremely well when the terminator has bisected the ring of *Archimedes* (33) a little way S.E. It is deserving of especial examination by those possessed of superior instruments, as in no part of the moon, perhaps, can this peculiar branch of the evidence of explosive action be studied to more advantage. Similar systems exist in other quarters; we shall recall the grand one of *Aristoteles*; we shall hereafter meet with others on a large scale; and I believe that careful search would detect them in places where they have not as yet been clearly described. But in the case before us, the distinctness and comparative simplicity of the radiation, as well as its favourable position with regard to our eyes, mark it out as a leading instance peculiarly adapted for the prosecution of the interesting inquiry, What was the nature of the force by which these cavities were produced, and through what processes did they receive their present form? The time is now coming when such investigations may be carried on upon more reasonable grounds. M. Chacornac has already distinguished himself by his original and ingenious speculations, and as observations are multiplied, selenological theories will be proposed, discussed, and some of them, no doubt, abandoned in their turn. On the present occasion, I venture to submit the following entry from my observing-book: the date being 1863, Dec. 17, the terminator being in progress from bisection to inclusion of the ring of *Aristillus*; instrument, my 5¼ in. achromatic, power 170; air unsteady; definition "imperfect and uncomfortable."

"The lava streams finely seen; they are confined to the lower part of the glacis, as in *Aristarchus*. The wall proper is a narrow ridge, showing no sign whatever of having been overflowed or broken down, but clearly of a horizontal character like a terrace; beneath its foot on the S.W. are two sharp, steep, narrow terraces; W. and N.W. there are irregular and rounded mounds; but in each case the source of the lava lies beneath, as though it had squeezed its way through beneath

(in which case the wall would scarcely have been so continuous and regular), or more probably had flowed previously, the upper regions being elevated in a cooler and less fluid condition."

Upon so imperfect a ground no theory ought to be, or is attempted to be, put forward. The extract is given merely as a specimen of the ideas which might naturally occur to any observer, as they did to myself, on examining this instructive formation as the sun was rising upon it. They may be very unfounded: possibly a further exploration might lead me to reject them for fresh notions, in the opinion of other observers equally baseless. But it is by a tentative process of this kind that we are most likely to approach the outskirts of that truth which the great Creator has perhaps willed to be in its fulness an impenetrable mystery. This we may plainly see, that such a radial arrangement must have been determined, like the circular form of the crater, by a central force: but in what manner, it is less easy to conjecture. The divergent matter might have been extruded in a semi-fluid condition analogous to lava; a condition again which might have originated either in igneous or aqueous action. It might have been poured out before the final formation of the ring, or have pierced the flanks of the mountain, as frequently happens in terrestrial eruptions, or have flowed over the ridge subsequently without leaving any trace perceptible to our vision, from the already hardened condition of the wall, and its standing up so steeply as to cast off the viscid matter to the more gradual slopes below. These radiations may be streams of enormous blocks in a non-coherent state, like beds of cinders on the flanks of a terrestrial volcano; and such torrents might have had their source either in the downpour of ejected fountains of stones, or in the overflow of a great mass of similar matter collected within the crater, and making its escape chiefly through gaps in its highest ledge. Such speculations may be, some of them, very improbable, but perhaps are none of them to be rejected for their dynamical impossibility. Each of them, therefore, might be compared with the observed appearances; and from rough hints of this kind, well applied here, and extended to other formations in distant quarters, some inference might, perhaps, result which might be worthy of serious consideration.

Aristillus is also the centre of a system of those mysterious light-streaks so familiar to every observer, and so difficult of explanation. Many of these diverge on the W., N.W., and N. sides; on the E. they extend to some distance through the *M. Imbrium*. It is well worthy of notice, that, except in a few instances, they do not coincide with the

rows of hills; and on the S., where the ridges are boldest, and fill all the space as far as *Autolycus*, they are entirely wanting. This entire independence of hill-radiation and light-divergence is a singular, but general characteristic of the moon.

A short distance S. of *Aristillus*, we find another grand crater, *Autolycus* (22), similar, but somewhat inferior to its neighbour in almost every respect. Its breadth is twenty-three miles; its depth beneath the E. wall 9000f., the height of the W. wall 8400f. above the cavity, 4800f. above the exterior base. The latter measures are given at 8800f. and 6000f. by Schr., who observes that the great Canigou, the chief of the E. Pyrenees, would stand in its interior. The larger ratio of its depth, and the small dimensions of its central hill show some modification of eruptive force as compared with *Aristillus*, but it is surrounded in the same way, though not to so great an extent, by radiating streams of blocks or lava. Where these two systems approach and mingle with each other in the space between the craters, might it not be possible for some of the most powerful telescopes of the day to detect evidence of unequal date? The light streaks which Schmidt ascribes to *Autolycus*, though in a less degree than to its neighbour, were neither drawn nor described by his predecessors, and this is so far worthy of notice, that the permanency of these uncomprehended markings has hitherto been assumed rather than proved. The streaks of *Aristillus*, he says, are best viewed in the wane. Schr. has remarked that the interiors of these two craters, like those of *Cleomedes*, *Endymion*, *Schickhard*, and others, grow darker under a higher angle of illumination. I have seen in the decreasing moon, when the terminator lay a little less than its own diameter beyond *Posidonius*, a remarkable ledge on the interior slope of the wall of *Autolycus*, marked through more than a quadrant by a separate shadow.

A singular remark of B. and M. in this place must not be omitted, to the effect, that such combinations of two (or even more) craters are frequently met with, lying under the same meridian, in which the steepness and formation of the wall within and without, the relative height and reflectiveness, in short, the whole character, are nearly the same, and both are equally conspicuous. If they differ in size, the smaller lies S., and in that case their diameters are in the ratio of three to four; they are about 18 to 36 miles apart; and connected by several more or less marked ridges running from the N. to the S. crater in a S.W. direction. Examples, Aristillus and Autolycus; Petavius and Furnerius; Agrippa and Godin; Aristoteles and Eudoxus; Ptolemæus, Alphonsus and Arzachel;

Schickhard and Phocylides; Scheiner and Blancanus, Moretus and Short; Geminus and Burckhardt.

Occultations.—April 8th. ALDEBARAN, 2h. 9m. to 3h. 9m.—9th. 130 Tauri, 6 mag. 7h. 33m. to 9h. 40m. The former will be interesting, as taking place in broad day; but it will probably require an equatorial mounting to find the moon, being then a crescent of less than four days old.

ON A FRESH WATER VALVED VAGINICOLA.

BY HENRY J. SLACK, F.G.S., HON. SEC. R.M.S.

In Pritchard's *Infusoria* (4th edition) is an account of a valved Vaginicola, described by Dr. Wright, and sketches of the creature are given in Plate xxviii., Figs. 18 and 19. It is described as "distinguished from *V. crystallina* by the remarkable valve existing in its case or sheath—which closes in an inclined position over the animal, when it retreats to the bottom of its case; by the body being colourless, without the green globules seen in *V. crystallina*, and by being an inhabitant of salt water instead of fresh." No size is given of the valved species, but *V. crystallina* is stated to be 1—210″ in the length of its tube, or "lorica," as these tubes are absurdly called. Dr. Wright's *Vaginicola* is represented with a straight-sided cylindrical tube, and when the animal is retracted, the valve, as shown in the drawings, forms a conspicuous dark line slanting upwards "across the tube, commencing rather higher than half way up, and terminating on the opposite side between one quarter and one-fifth below the tube's mouth." When closed the valve is shown as pressed on one side of the tube.

The form of Dr. Wright's animal is like that of an ordinary Vaginicola when expanded, with the usual ciliated peristome and when retracted, it is shown as a long oval, pointed at the foot end.

I am not aware that anyone else has described a valved Vaginicola, and if not, the one now mentioned may be new. It was found on a sprig of myriophyllum, kindly given to me by Mr. H. Davis, with some specimens of the new rotifers discovered by him last year in a pond between Walthamstow and Leyton. In point of size it is much larger than *V. crystallina*, having a tube nearly 1—100″ long, and irregular in shape, as

shown in the annexed sketch. Part of these irregularities had the appearance of accidental dents, and the form of a perfect specimen might be nearly cylindrical with a rounded bottom.

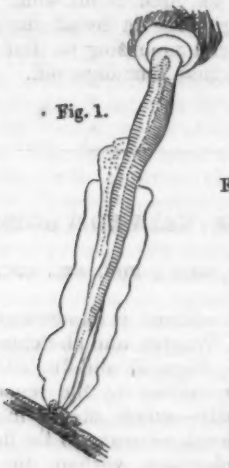


Fig. 1.

Fig. 2.

Fig. 3.

VAGINICOLA AQUATICA VALVATA.

The valve, or door, came close to the top of the tube, and was extremely delicate and transparent. The tube was inhabited by two animals, one larger than the other; the smaller one being probably an offspring produced by the fission of its parent. In retreating, the two creatures gave themselves a spiral twist, and both emerged together, shoving the door open before them. On their retreat, the door closed by the elasticity of a reduplicated portion, which acted as a spring. The diagram, Fig. 3, shows the nature of this construction. A is the door or valve, and B, the springy part, turned up against the side of the tube, and compressed each time the door was thrust back and opened.

The bodies of these creatures were finely striated in a transverse direction, and they contained numerous patches of green matter, like bright chlorophyll. The contractile vesicle was very noticeable, but the other organs were obscure, and an early loss of my only specimen prevented any detailed examination. The presence or absence of green globules can scarcely be regarded as indicative of specific distinction in creatures of this description, being probably nothing more

than the result of particular sorts of food. If the animal now described is new, it may be called *Vaginicola aquatica valvata*, thus distinguishing it as belonging to fresh water, and leaving open the question of whether it is to be regarded as specifically distinct from Dr. Wright's marine *V. valvata*, or merely as a variety, a matter not to be conclusively judged of without comparing a good many specimens.

Fig. 1 represents the animals protruded from their tube—one stretched to nearly its full length, and showing its ciliary wreath, the other only partially expanded. Fig. 2 exhibits them retracted with the spiral twist already mentioned. The valve, or door, is so delicate, as very easily to escape observation, except in those parts which have flocculent adhesions. Probably many more instances of valved forms may be discovered if the valves are carefully looked for. For this purpose, the illumination must be good, the light not too strong, and advantageously coming from an achromatic condenser. Excess of light or erroneous direction made the valve invisible in the specimen described, and the clearest portions could scarcely be distinguished in refracting power from the surrounding water.

Vaginicola aquatica valvata; tube approximately cylindrical, rounded at bottom, 1—100″ long. Animal much like *V. crystallina*, but bigger; when expanded, 1—50″ long, delicately striated transversely; retreating into its tube with a spiral twist. Valve reaching the mouth of the tube: when closed, slanting at about 45°. Valve consisting of a stiff plate of hyaline material, with reduplicated portion acting as a spring to close it.

BIELA'S COMET.

BY W. T. LYNN, B.A., F.R.A.S.,
Of the Royal Observatory, Greenwich.

(With a Tinted Plate.)

After performing the extraordinary feat of separating, twenty years ago, into two portions, this remarkable comet appears now to have vanished entirely; most vigorous and patient searches for it last year, at a time when it should have been conspicuous, having met with no success. The writer has been induced to think that, under these circumstances, an account of all the facts known concerning it, carefully digested into a small compass, would prove interesting, and, acting upon this belief, he has drawn up the following:—

On the 10th of November, 1805, this comet was discovered by M. Pons, at Marseilles, in the constellation of Andromeda. It was then a small comet, with tolerably defined nucleus, discernible by, but not conspicuous to, the naked eye. It afterwards increased in brightness and apparent size, and was observed by many astronomers, including Olbers, Schröter, Harding, and Wrekolyne. According to the measures of [illegible] the diameter of the nucleus on December 8 amounted to about 1,200 miles, whilst that of the spherical nebulous shell was more than fifty times as large, or nearly 6400 miles. That astronomer compared this proportion with that derived from his own measures of the comet of 1799. He found that the visible envelope of the latter was more than twice as large as that of the other, when each was at its respective nearest approach to the earth; and as the visibility of the successive layers of the envelope, since they always decrease in density in proportion to their distance from the nucleus, depends greatly upon the comet's distance, he concluded that the extent of that of 1799, which never approached the earth nearer than seventy millions of miles, was in reality far greater than that of 1805, which came within four millions of miles. Now, as the diameter of the nucleus of the comet of 1799 amounted to 1,500 miles, the cubical contents of that nucleus was about 1,000 times as great as that of the comet in question; hence the assertion appeared justifiable, that the mass and attractive force of the nucleus of a comet is the principal cause of the extent of its luminous envelope, which may be supposed to consist of attracted particles of ethereal matter. On the 8th of December, when the comet was nearest the earth, the former, which, from its then considerable southern declination, was observed by Schröter at no great

* *Berliner Astronomisches Jahrbuch* for 1809, p. 140.

South

Feb. 19, 1846. *fig.* 1.

Feb. 21, 1846. *fig.* 2.

West

East

Sept. 20, 1852. *fig.* 3.

Sept. 25, 1852. *fig.* 4.

North

J. Carpenter, del.

STRUVE'S VIEWS OF BIELA'S COMET.

elevation above the horizon, appeared to the naked eye as a roundish, luminous, nebulous mass, nearly as large as the moon, and without any tail.

When the orbit of the comet was calculated, it was found that its elements were not very different from those of one discovered by Montaigne, in the year 1772. But more accurate investigations, made by Bessel and Gauss, on the supposition of an elliptic orbit, showed that the conjecture that the two comets were identical, was at least a very doubtful one. But, as Montaigne's comet had been very imperfectly observed (it was visible only for a very short time), Gauss remained of opinion that they were in fact one comet, with a period of about five years; though Bessel, on the other hand, was unable to assent to this.

We now come to the time when this remarkable comet acquired the name by which it has since been known. On the evening of the 27th of February, 1826, Biela, at Josephstadt, in Bohemia, discovered a comet which then appeared as a small round nebula, with a very fine point of light in the centre. Other astronomers afterwards observed it, of whom Gambert was the second, who independently discovered it at Marseilles, and says, "It has neither tail nor nucleus, but appears like a feeble nebulosity, the light of which is a little more intense towards the centre."* This was on the 9th of March. Harding observed it at Göttingen, having heard of it from Biela, and on the 14th of March perceived a small tail. The comet was in perihelion on the 18th of that month. At no time during this or any subsequent appearance was it visible to the naked eye; and it ceased on this occasion to be perceptible to the telescopes in the month of May. Biela himself† was the first who arrived at the conclusion, which all the calculators afterwards confirmed, that the comet had a period of about six and a half years, and was identical with that of 1805. He, indeed, suspected also that it might be the same as those seen in the years 1772, 1779, and 1812; but the latter two suppositions proved to be not tenable, and the former one continues, as we have already hinted, only a probability, whilst the identity of the comet discovered by Pons, in 1805, with this of Biela is an unquestionable fact. Thus, for the fourth time, was a comet's period of revolution round the sun satisfactorily determined, the three preceeding cases being those of the comets of Halley, Olbers, and Encke, whose periods are respectively 76, 74, and only 3¼ years.

* *Astronomische Nachrichten*, No. 92.

† He informed Schumacher that he had in fact partly expected it. Biela had already a cometic reputation, and had independently discovered a comet the previous summer, although on that occasion he was anticipated by Pons.

At this appearance the comet approached very near the earth's orbit; and it was calculated that, at the next, in 1832, it would approach still nearer. This proximity was, however, only to the *orbit* of the earth, which that of the comet intersected in such a manner, that when the comet itself crossed the ecliptic, on the 22nd of October, the earth was at no less a distance than forty-four millions of miles. But had the latter been then a month in advance of its actual place, it would have passed through the comet—"a singular rencontre," writes Sir John Herschel, in his *Outlines*, "perhaps not unattended with danger." The general public, indeed, received the announcement that the comet's orbit intersected the earth's, and that therefore, a collision was at some time possible, with feelings of considerable alarm. The celebrated Olbers showed that such a collision, or rather a very close approach of the earth and comet could, according to the laws of probability, take place, at the most, only once in about 2,500 years. Much to his chagrin, this expression was perverted, in many publications, into a very different one, that a collision between the earth and comet would actually take place at the end of 2,500 years from that time.

The first place at which the comet was seen in the year 1832, was at Rome, on the 25th of August, being detected early in the morning in the constellation of Auriga. This was by the use of the excellent ephemeris of Santini, who from that time has kept the comet under his protection. At the time of the discovery its light was feeble and nebulous, but by the 28th of the same month, it had considerably improved. The second observer was Sir John Herschel, at Slough, whose remarks must be given in his own words: "On the night of the 23rd, or morning of the 24th, of September, I observed Biela's comet, and again next morning (24th-25th), as it was then a bright object, and found without the least difficulty. I pursued it no farther, which I now regret, as I have not since heard of its having been seen so early elsewhere, unless, as it is said, at Rome, which, if verified, will be a great proof of the advantage of an Italian sky. But from the extreme faintness of it in the equatorial, on the 23rd and 24th of September, I can hardly imagine with what instrument this observation can have been made. I have since observed it on the 4th and 5th instant"* (*i.e.*, of October). By a "bright object," in the first sentence, Sir J. Herschel evidently meant comparatively to what he expected. Nicolai observed it at Mannheim, on the 21st and 24th of October, and describes it as being a small and excessively faint nebulous patch, only to be seen by great straining of the eye. Bessel also, who observed it at Königs-

* *Ast. Nach.*, No. 220.

berg, on the 20th of that month, states that a small star near it so enfeebled the comet by its superior light as almost completely to obscure it. The renowned Struve observed it at Dorpat, and on the 7th of November saw it almost centrally cover a star of the ninth magnitude. Later in November, the comet's light became somewhat greater and more condensed. At the Cape of Good Hope it was observed until 1833, January 3, by Henderson, who states that its brightness was only nearly the same as that of Encke's comet during part of its preceding apparition. It passed its perihelion on the 28th of November, 1832.

On its next return, in 1839, it was not seen at all, being too near the sun. But on the succeeding return, in the years 1845-6, those remarkable phenomena were seen which have ever since made Biela's so famous amongst comets. In October, 1845, Mr. Hind calculated an ephemeris from the elements of Santini, but he failed, notwithstanding great diligence, in being the first to detect the comet. An Italian sky again gave the priority to the observers at Rome, where it was seen by De Vico on the 26th of November; and on the 28th, Dr. Galle, at Berlin (the same astronomer who the year after was the first to see Neptune with the knowledge of its planetary character), also succeeded in perceiving it, close to the calculated place. It resembled an excessively faint nebula, and not till the evening of the 29th of November, when it was found to have moved according to the ephemeris, did the Berlin astronomers feel convinced that it was actually the expected comet. Encke himself declared that he should not have seen it had it not been pointed out to him, and for several nights he had to assure himself of its existence. Professor Challis observed it with the Northumberland telescope at Cambridge, on the 1st and 3rd of December.

On the 27th of January, 1846, Mr. Airy wrote to the Editor of the *Astronomische Nachrichten*—"Professor Challis has found, and the observation has been confirmed by Mr. Hind, that Biela's comet is double. Since I received notice of this, the weather has been excessively bad. It is evidently a thing which deserves the utmost attention of astronomers."* On the 29th of the same month, Encke wrote thus to the same periodical: "Biela's comet offers so remarkable a figure that I cannot help calling attention to it. Immediately on looking for it with the smaller 3½-feet Dollond, d'Arrest found that the comet consisted of two completely separated cometary nuclei. This was on the 27th of January. In the refractor it appeared the same. The fainter nucleus is to the north of the other. There is in both a trace of a tail, its direction being

* *Ast. Nach.*, No. 553.

in both perpendicular to the line connecting the two nuclei. The first conjecture was that we had a second comet or a nebula. But they move together with equal velocity, and in the same direction." Challis appears to have been the first European observer of this extraordinary appearance, on the 15th of January. Sir John Herschel observed it on the 28th, and remarks, "What surprised me was the roundness of the almost detached nebula, and its distance." Bessel, at Königsberg, remarked the change the same day as Professor Challis. The day before (January 14th), he states that he saw nothing unusual in its appearance, but on the 15th, the air being clear, and the moon not yet risen, he saw quite distinctly two separated nuclei, the one from three to four times as bright as the other. News afterwards arrived from America that this extraordinary phenomena had been seen at Washington as early as January 13th, by Lieutenant Maury, who then thought, like Encke, that the smaller nucleus was a nebula, or fainter comet near Biela; but on January 14th, observing before moonrise, he wrote in his note-book, "Biela has a companion close aboard! The acolyte is about as faint as Biela was in the moonlight of the 12th. Looking through the corner of my eye, I can catch glimpses of a tail to each. Biela's tail reaches off N.E., and his companion's is nearly parallel with, but slightly inclined towards, it."* The first suspicion of anything unusual was expressed by Mr. Hind, who, on the 19th of December, 1845, described the comet as being "somewhat elongated, or pear-shaped," but that circumstance, he tells us himself, was merely mentioned as a passing notice, such distortion being not unfrequently noticed in telescopic comets.†

Both divisions continued to travel together at very nearly the same real mutual distance, although from their respective visual positions, the apparent distance considerably increased. The actual distance, however, from the beginning of February until the middle of March, continued to be about 150,000 miles. Meanwhile, some very extraordinary changes of appearance manifested themselves. Whereas, at the time of separation, the new, or companion comet, was extremely small and faint in comparison with the other; this difference gradually diminished until, on the 10th of February, the two were nearly equal. Afterwards, the new comet gained a decided *superiority* of light over the old, presenting also a sharp and star-like nucleus. This, however, lasted but a few days, the original comet re-asserting its superiority, and becoming, by February 18th, nearly twice as bright as its companion, which now began to fade away, and ceased to be visible after the 15th of March, although its originator was

* *Ast. Nach.*, No. 561. † Hind's *Comets*, p. 77.

seen until nearly the end of April. Another curious phenomenon was noticed in America in February. The companion comet, besides its tail, extending in a direction parallel to that of the other, threw out a faint streak of light, like a bridge, towards the other, whilst the latter threw out additional rays, presenting the appearance of a cometary nucleus with three tails, one forming an archway of cometary matter extending to the nucleus of the companion comet.

The comet was also observed after its division by Otto Struve, with the great refractor at the magnificent observatory at Pulkowa, in Russia, of which place his distinguished father, Wilhelm Struve, was then Director, and in which, since his father's death, he has so worthily succeeded to his office. From his observations on the 19th and 21st of February, the drawings were made, representations of which are given in Figs. 1 and 2 of our Plate. They show the change in the appearances of the two nuclei during that short time.

At this return the comet's perihelion passage took place on the 11th of February. The last day it was observed was on the 27th of April, by Professor Argelander, at Bonn, near Cologne.

Of course its next apparition was eagerly expected, though, from its position on that occasion, it could only be visible for a short time. Again was it first seen at Rome; this time by Father Secchi,* on the 26th of August, 1852, at about half-past 3 o'clock in the morning. Shortly after that hour, it centrally covered a small star of the 9-10th magnitude, producing the appearance only of a slight nebulosity surrounding the star. On the morning of the sixteenth of September, the same astronomer saw also the separated companion comet: it was very faint, without nucleus, and of elongated figure, the elongation being on the opposite side to the sun. The observation was altogether very difficult, because, almost as soon as the comet got out of the mists of the horizon, its light was enfeebled by the increasing twilight. Two nights afterwards it was observed at Berlin. Subsequently it was seen at Cambridge: the shape was elongated, but the companion was not perceived. There was, however, another witness of the continued duplicity, namely, Otto Struve, who again observed the comet with the powerful refractor at Pulkowa, near St. Petersburg. He first saw it on the 18th of September, but could then only perceive one of the nuclei, which proved to be the northernmost of the two, and *not* the one first seen at Rome, which was the only one observed at Cambridge, so much had the relative brightness changed. Struve describes it as being in amount of light about equal to a star of the 8-9th magni-

* *Ast. Nach.*, No. 822.

tude, with scarcely a decided nucleus, but a condensation of light towards the centre. Two days afterwards (Sept. 20) the nucleus had become decided, and that of the other division of the comet was also perceived, of scarcely inferior brightness. Fig. 3 gives a very correct representation of a drawing made by Struve on that day. On September 23rd the nucleus of the fainter comet, or division of comet, was hardly perceptible. On September 25th, another drawing was made, represented in Fig 4. The brighter comet was now oblong in shape, the other much fainter. On repeating the observation on Sept.. 28th, the second nucleus, or the one first seen at Rome, was not distinguished at all; the other was seen and observed with some haste, because of the increasing twilight. This was the last observation made anywhere.* It must be remarked that the mutual apparent distance of the two nuclei was considerably greater than in 1846. The distance, however, of the comet from the earth was about twice as great as when it was in perihelion in that year, viz., 126 instead of 56 millions of miles.

At the next return to perihelion, in 1859, the comet was too near the sun to be seen. It cannot, therefore, be said whether it *did* return or not.

The next appearance, in 1865-6, was most eagerly expected, and the comet was most diligently looked for at nearly all the great observatories, but, to the great disappointment of astronomers, it was nowhere seen. The conclusion from the failure of these attempts to recover the lost wanderer, seems to be, that it is completely dissipated; and this conclusion Professor d'Arrest, who devoted with great zeal, on every possible opportunity, the fine instrument he now has at his command at Copenhagen to the search, has not hesitated recently to express with considerable confidence.† This dissipation we may presume to be a consequence of the same feebleness of attraction which, in 1846, caused its separation into two portions. And yet it was with this dispersed, scarcely-cohering matter, that all Europe, in 1832, was alarmed at the possibility of a collision. Again and again has astronomy been asked whether she can indicate the means whereby the Almighty will one day accomplish the destruction of our globe? Again and again has she answered in the negative. There have also been those who have demanded of her the steps by which He was pleased to create this scheme of things, this beautiful system, this wondrous kosmos of which our earth and our-

* *Memoires de l'Académie Impériale des Sciences de St. Petersburg.* Sixième Série. Sciences Mathematiques et Physiques, Tome VI.

† *Ast. Nach.*, No. 1624. A translation by myself is given in the *Astronomical Register* for March 1867.

selves compose parts. Theories have been formed from astronomical facts, but such theories have always been deficient in anything like firm foundation, in aught but a kind of plausibility. The one solid answer remains alone in all its grand simplicity—"He spake, and it was done; He commanded, and it stood fast."

FRESH NOTES ON THE CRATER LINNÉ, AND SUPPOSED LUNAR ERUPTIONS.

The *Astron. Nachr.* publishes a letter from Schmidt, in which he says, that "at the time of Lohrmann's and Mädler's work, from 1822—32, Linné was more than 5000 toises wide, and had a very deep crater, plainly visible as such, and when near the phase, more or less in shadow. It was the third in size of *M. Serenitatis'* craters, and was seen and described by Schröter in 1841—3, and by me." What seems deficient is, positive evidence of the crater-form appearance of Linné, at a more recent date—say shortly before 16th Oct., 1866, since which, Schmidt states that no crater has been visible. His words in this letter are: "At least since Oct. 16th, 1866, the crater form of Linné at a time of oblique illumination cannot at all be recognized, (*durchaus nicht warhgenommen werden*). The Athens refractor shows at times in the interior a fine black point (*feinen schwarzen punkt*), 300 toises (1918·4 English feet), in diameter."

Schmidt further observes that in high illuminations Linné is always visible as a light spot, and has been so for more than twenty years; and then comes the following passage, which should be considered in connection with the following letter of Secchi's to the French Academy, and with the fact that several English observers have noticed a more or less distinct black spot.

"If strong eye pieces of 500 to 1000 times magnification occasionally give indications of a crater-form, it is especially necessary to state whether such crater is deeply shadowed, and has the old diameter. If such were the case, at present, large telescopes would not be necessary, and the questions now raised would not have been propounded."

Schmidt further states that he has satisfied himself by observations during four lunations that Linné is now "never to be seen as a crater of the normal type."

At a recent meeting of the Imperial Academy of Vienna, Herr Haidinger read a letter from Schmidt, detailing sundry

facts which are already in the possession of our readers, and treated the appearances presented by Linné as the first proof furnished with perfect certainty of a change in the moon's surface. Herr Haidinger likewise read a second letter from Schmidt, which we give, as translated by W. J. Lynn, Esq., F.R.A.S., from the *Cologne Journal*:—

"An eruption of vapour or ashes is not probable, because a shadow of that which covered the crater would be thrown at sunrise and sunset, but this is never the case; such must *also* be visible at the phase, which is not the case. Had the crater sunk below, in its place a great shadow *would* be visible during the phase. Had the ring-mountain been destroyed, the fragments would throw shadows, which also is not the case. Had the crater been filled up by an eruption of fluid or powdery matter, without overflowing, the interior black shadow at sunrise and sunset would indeed disappear, but there would remain a hill, throwing a shadow on the outside. This was the appearance seen by Schröter in 1790, in the central crater of Posidonius, and by Julius Schmidt, in the same object, in the month of February, 1849. But such a mass of matter may also have flowed out over the outside banks, and covered the surrounding declivity, with very gradually sloping inclination. This would prevent the casting of a shadow outside at the phase. Such an event would explain all the phenomena presented by Linné, and it is the kind of event which in the mud volcano of the peninsula of Taman, so closely described by Abich, has so striking an analogue upon our earth. The spreading of the overflowing bright mass over the dark plain gives occasion to the origin of broad formations similar to a halo, which are frequently seen upon the moon, especially in the so-called '*Maria*.' Here lies the key to new enquiries and points of view; a hope for the future."

"Herr Schmidt had already received information from Mr. W. R. Birt, of London, one of his correspondents, that the latter had also confirmed the fact of the disappearance of the crater Linné, and that an account thereof had been communicated, by a circular of the Lunar Committee, to astronomers interested in it."

"The long and indefatigable exertions of our highly-honoured friend, Julius Schmidt, have therefore been crowned by a result for which even Mädler, although he did not resign the hope, remarked, however, that although he had laboured to discover traces of changes on the moon's surface, he was obliged to confess that all the labour hitherto spent upon that object had led to no positive result." (*The Natural Sciences, etc.*, vol. iii. p. 573.)

"What agonizing interest would this event have given to our

immortal Humboldt, who, in his *Kosmos*, places together in their order, Lohrmann, Mädler, Julius Schmidt, for their instructive and original labours upon the moon (for example, in vol. iv., pp. 614 and 615) and who constantly took interest in, and recognized with pleasure the value of the results of the labours of the latter."

"Our readers will peruse with interest the following

REMARKS ON THE ABOVE BY W. R. BIRT, F.R.A.S.

"One of the most important features in the above sketch of hypotheses is that of the mud-volcano being the terrestrial analogue of the phenomenon recently observed on the *Mare Serenitatis*. As Dr. Schmidt very justly remarks, the appearance presented by Linné receive an explanation on this view. In the very interesting paper on the mud-volcanoes and salt lakes in the Crimea, by Professor Ansted (INTELLECTUAL OBSERVER, vol. viii., p. 409) it is recorded—the well-known naturalist, Pallas, being the authority—that in the year 1794, on the 27th of February, from the cone near the delta of the river Kuban, large quantities of mud were thrown out, accompanied by flame, which continued half an hour, and rose to a height of 150 feet above the ground. The height of the cone was 250 feet. The mud thus thrown out is said to have spread over the plain, but the rapid eruption was soon over. Twenty years afterwards, Engelhardt mentioned two craters, each about 50 feet in diameter. At present, after a further interval of more than fifty years, the vent is nearly closed up, although the cone rises at least 250 feet above the plain of the delta, and possesses a crater of a very distinct form.

"It is highly probable that the eruption in Linné was *sudden*, and, taking into consideration the size and depth of the crater, a very considerable quantity of matter must have been injected from below. In my former remarks on the phenomenon (INTELLECTUAL OBSERVER, vol. x., p. 444), I suggested that the crater itself had been concealed, but it appears from Dr. Schmidt's, as well as from the English observations, that the crater is not only actually *filled*, but that a hill of nearly 2000 English feet in diameter, and about 40 feet high, exists where a deep cavity was formerly seen.

"The fine black point and white summit are interesting, and are features which should be most assiduously watched, especially by means of large apertures. Mr. Webb (see INTELLECTUAL OBSERVER, vol. x., p. 442) records the discovery of a minute pit on the summit of a mountain north of Aristotelis. Of the recent formation of the hill—*we may now say*—on Linné,

there can be no doubt, it having been recorded by several observers. I also mention (INTELLECTUAL OBSERVER, vol. x., p. 445) a somewhat similar object on the Mare Crisium, west of Picard. The evanescent or permanent character of these and similar objects it would be well to determine. In his last communication to me, Dr. Schmidt mentions a faint, light tail, of about 4·6 English miles in length, perhaps analogous to the streaks from Messier. This he did not remark until Jan. 24, 1867. It may have originated from a further overflow of the matter filling the crater. This also is an object deserving of attention.

"The similarity of the reflective power of Linné under a high illumination, both before and after the change that has taken place, is curious. It appears to indicate that whatever may be the nature of the injected material, its reflective power is much the same as that of the interior surface of the former crater during the last 20 years; and, comparing it with the records which we have of the former brightness of Linné, *the reflective power has declined of late years.* (INTELLECTUAL OBSERVER, vol. x., p. 446.)

"Connected with this subject, we find—very extensively indeed—scattered over the moon's surface, especially at the time of full, both small and large bright spots, some of which, when near the terminator, are seen as craters; while others, even under the greatest amplification, exhibit nothing whatever of the crater-form. The Rev. W. R. Dawes notices spots of this nature in his interesting description of the small craters which he observed on Plato in January and April, 1863 (*Monthly Notices of the Royal Astronomical Society*, vol. xxiii., p. 222). It would be well for observers carefully to watch from time to time these bright spots, especially as we have now a veritable instance of the formation of one, which possibly may undergo further change, and it is not unlikely that changes may be detected in some others. As a large number of these bright spots are found on the *Maria*, monographs of the craterology of each *Mare*, such as I have attempted for the *Mare Crisium*, would be very valuable. See *Report of the British Association for the Advancement of Science*, 1865, p. 292."

PRODUCTS OF VOLCANIC ACTION.

With a view to facilitate a comparison between lunar and terrestrial volcanic action, the following facts and considerations may be useful.

Volcanic action on the earth results from a highly heated condition of large masses of matter below the surface of the globe; but it is not necessarily, or even probably, directly connected with a great internal molten sea, such as many geo-

logists imagine to exist beneath the solid crust of our planet. The depth of earthquake movements, or rather, of the focus of earthquake disturbance, has been investigated by Mr. Mallet, in his work on the Neapolitan earthquake of 1857,* and from mathematical considerations, applied to actual observations, he arrived at the conclusion, "that out of twenty-six separate wave paths, twenty-three started from the seismic vertical, at a depth of about $7\frac{1}{4}$ geographical miles, or of 43,284 feet. The maximum depth is $8\frac{1}{4}$ geographical miles, or 49,359 feet, and the minimum depth is $2\frac{3}{4}$ geographical miles, or 16,705 feet. Eighteen of the wave paths start from the seismic vertical within a vertical range in depth of 12,000 feet, and having a common focal depth of $5\frac{1}{4}$ geographical miles, or of 34,930 feet, which may be taken as the depth of the focus. The extreme vertical range between maximum and minimum depth is 32,654 feet. On examining the diagram, however, having regard to the points in the seismic vertical where the wave paths start thickest, it will be apparent that the probable vertical depth of the focal cavity itself does not exceed 3 geographical miles, or 18,225 feet at the outside."

Applying the same principle of calculation to the larger earthquake phenomena of South America, he considers that the greatest probable depth of earthquake action is somewhat less than thirty-one geographical miles, and, "therefore, only just touches the depth which upon received notions, as to the increment of hypogeal temperature, is supposed to form the upper surface of the imaginary ocean of liquid lava of the earth's interior."

The connexion between earthquakes and volcanoes is generally admitted, and though earthquakes frequently occur at considerable distances from volcanoes, an eruption of the latter usually acts as a safety valve, and lets out highly-heated materials which would otherwise, by their efforts of expansion, produce tremendous shocks. Volcanoes, like earthquakes, may result from chemical actions at the moderate depths spoken of by Mr. Mallet, and if this is the case on the earth, it may be so likewise on the moon.

On the earth, the magnitude of volcanic forces, whether exhibited in eruptions or earthquakes, seems to stand in frequent, if not constant relation to the height of mountain chains, and the depths of the *foci* of disturbance probably vary considerably, as Mr. Mallet suggests. If we apply this principle to the moon, Linné would be connected with the volcanic district of the Caucasus and the Apennines, which are amongst the highest of the lunar chains, the former reaching an extreme elevation of 17,138 Paris feet, and the latter of 16,934 Paris feet, or one-

* *First Principles of Observational Seismology.*—Chapman and Hall.

twelfth more English feet, and would therefore be very nearly, if not quite in a region of maximum volcanic force.

The moon offers no *positive* evidences of having had its surface modified by aqueous action, and if no such action has occurred on an extensive scale, the appearances presented may be those of a much more primitive condition than are now found on our earth. The larger craters may date back to a period of igneous plasticity, and eruptive action may now be on a much smaller scale, and also more local in character, than it was in former ages when the surface was less solid, and the heat below the surface more equally diffused and more intense.

The matters erupted by terrestrial volcanoes are vaporous and gaseous as well as solid, and water frequently occurs in what are called "igneous rocks." Following Cotta's division,* such rocks are arranged in the two classes, *volcanic* and *plutonic*, the former comprehending such as "have solidified at or near the surface, and the latter those which have solidified at a considerable depth in the interior of the earth."

Taking the whole range of igneous rocks, Cotta gives the following "extreme average values of their chemical constituents":—

Silica	50—80
Alumina	10—25
Peroxide and protoxide of iron .	1—25
Lime	0—15
Magnesia	0—12
Potash	0—10
Soda	0—7
Water	0—5

Another division of igneous rocks refers to their being richer or poorer in silica, which behaves like an acid. Those most rich in this constituent are called *acidic*, and those less rich *basic*, and both kinds frequently contain small quantities of water.

When terrestrial eruptions occur, vapours of water, sulphur, etc., and gases, are abundantly emitted. In the words of M. St. Claire Deville, "lava never flows forth without bringing with it immense quantities of gaseous matters and vapours. These last may, indeed, appear singly, but everything indicates that they escape from stony masses in fusion situated more deeply."† Water coming into contact with such masses must be immediately converted into high pressure steam; and wherever large quantities of vaporized substances are emitted,

* Cotta's *Rocks Classified and Described.*—Longmans.

† *Comptes Rendus*, No. 26, 1866.

their condensation, as they become cooler, gives rise to the great masses of cloud and smoke which form so striking a feature in most eruptions. Water is acknowledged by all authorities to play a very important part in all, or nearly all, varieties of terrestrial volcanic action, and if the volcanoes of the moon perform their functions without its assistance, they must differ widely from those of the earth.

The supposition of a mud volcano in the moon includes the belief that water exists in that body in cavities below the surface, if not upon it. But if water is poured forth in company with solid matters, might we not expect to see clouds and vapours? If the moon has no atmosphere, as is commonly asserted, evaporation from mud or water emitted by a volcano would be very rapid, and if the total quantity was very small, condensation would be inconspicuous even when the lunar temperature declined during the evening and night of our satellite.

The appearances of Linné are such, that if we are satisfied it was an empty hollow, or crater, a few years ago, we must regard it as having been filled to overflowing with some erupted material. If mud, then much vapour might be expected. If liquid lava, vapour and cloud would, we should suppose, have been formed at the time of the eruption, unless lunar volcanoes differ in their action from those of our earth, or the absence of an atmosphere causes instant evaporation, and precludes noticeable condensation. Actions of this kind might impair the visibility of particular objects while they were in process.

There are on the moon an immense number of spots, much resembling the present appearance of Linné; and if they had a similar origin, what are we to suppose has become of all the water vapour that must have been poured forth upon the mud hypothesis? Under the receiver of an air-pump, Dr. Miller states, that water may be made to boil at a temperature of 70°,* and Sir John Herschel thinks it possible that, during the lunar day, the moon's surface "may *possibly* be heated to a degree much exceeding that of boiling water."

Sir J. Herschel also says that we are entitled to conclude the non-existence of an atmosphere one 1980th part as dense as that of our earth, as the presence of such an atmosphere would give rise to a refraction that would be observed during the occultation and reappearance of stars. Under such circumstances, if any great quantity of water has at various times been poured forth by volcanoes from internal cavities, it must have been rapidly absorbed, and held fast by chemical action, or an atmosphere of vapour would be detected.

* *Elements of Chemistry.*

Secchi on Linné.

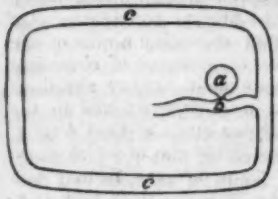
Father Secchi has sent to the French Academy a letter dated from Rome, 14th Feb., 1867, in which he says, "On the evening of the 10th, between nine and ten o'clock, the crater (Linné) entered into the sun's light, and close by the limiting circle a small prominent point was seen with a little shadow, and round this point an irregular circular corona, very flattened. The weakness of the light and the proximity of the moon to the horizon did not allow the observations to be prolonged. On the 11th, in the evening, Linné had already advanced into the light, and at seven o'clock, a very small crater was distinctly seen, surrounded by a brilliant white aureole, which glittered against the dark ground of *M. Serenitatis*. The size of the orifice of the crater was at most $\frac{1}{3}$ of a second, and the aureole was a little larger than Sulpicius Gallus. I insist on this comparison because it shows that Beer and Mädler could never have figured a crater as big and as well-marked as that which they assigned to Linné, for the white spot which at present exists; in fact Sulpicius Gallus is actually much larger than the little crater which forms the centre of the spot. This last is even smaller than those craters which are indicated merely by letters, without names, and which are distributed at great distances in *M. Serenitatis*. It cannot be doubted that a change has taken place, and it seems probable that an eruption has filled the ancient crater with a material white enough to look bright against the dark ground of the sea."

ARCHÆOLOGIA.

Among several discoveries of Anglo-Saxon cemeteries announced within the last few weeks, one appears to present some features of special interest. In the parish of Woodstone, within a mile of the city of Peterborough, a spot was dug for the purpose of obtaining gravel, in the course of which operation about twenty skeletons were disinterred, accompanied with the usual objects found in the Anglo-Saxon cemeteries, especially within the limits of East Anglia. Among these are to be remarked the cruciform fibulæ, of which there were a certain number, but of rather plain design. Among the circular fibulæ some were saucer-shaped, a class which is now considered to have been peculiar to the West Saxons, and therefore the circumstance of finding them in a cemetery in the neighbourhood of Peterborough is worthy of remark. Other round fibulæ were mere round plates of bronze, but with simple and rather peculiar ornament, with hinges on the reverse side. Bosses of shields, small spear-heads, and knives, were found in abundance, but not a single example of the long sword. Among other objects were several small buckles, and many beads in amber, earthenware, and glass, the latter chiefly green and blue. We have often had occasion to remark, that among our early Anglo-Saxon forefathers beads were worn by the men equally with the women, and we have found more than once a regular necklace round a man's neck. Perhaps they were considered as carrying with them something of dignity, as well as being objects of finery. We are informed that in one case, in the cemetery found at Woodstone, a string of beads was suspended across the bosom, one end attached to a fibula on each breast. The bodies appear to have been all interred entire, whereas cremation and urn-burial appear more usually to have prevailed among the Angles. They lay for the most part east and west, but some lay exactly north and south. Two urns of earthenware were found, but they were plain, and without ornament or pattern.

The exploration of the Trevenegge Cave, near Penzance, has been concluded for the present; chiefly, we fear, because the funds in hand were expended. Among the miscellaneous objects last turned up was an earthenware spindle-whorl, an object much more rarely found of this material than of stone. It resembles, in appearance and size, one of similar material figured in Sir John Lubbock's *Pre-historic Times*, which came from a Swiss Lake-dwelling. Many more fragments of pottery also have been found, but not a sufficient number of any one suite to form a complete vessel, though the shape of three have been tolerably well determined by the fragments. One of these, about nine inches in its greatest diameter, made of fine light brown clay, highly finished on the wheel, and glazed black without, is evidently Roman. The second, which is fifteen inches high, of rather coarse clay, and also wheel-formed, is of a form which is not very characteristic of a period, but appears to be copied from Roman. The third, which is glazed black on both sides, suggests strongly the notion of Anglo-Saxon.

They all give us the notion of their being rather late Roman, or of the period immediately following, but to what kind of settlement they belonged here it is very difficult to guess with the extent of our present knowledge. The cave is contained within an area surrounded by a ditch or fosse, and containing about half an acre of ground. Its position, and the passage from which it was entered, will be best understood by the slight plan here given, where *a* represents the cave, *b* the passage, and *c c* the ditch of inclosure. Numerous fragments of bones were found in the cave, some evidently belonging to a large animal, but in general they were so much calcined that it was difficult to decide upon their character. Some fragments were supposed to be human, and the directors of the excavations appear to be inclined to the belief that the cave has been at some time used for sepulchral purposes.



A short time ago, the remains of a ROMAN VILLA were uncovered near TRACY PARK, in the neighbourhood of Bath. The farm on which it was situated was named Cold Harbour, a name often found attached to Roman sites. At a recent meeting of the Bath Natural History and Antiquarian Field Club, the Rev. Prebendary Scarth gave an interesting account of the discoveries made in the course of the excavations. Before they were undertaken, numerous fragments of Roman pottery, tile, and cut stone, were seen lying about an arable field adjacent to the pasture field in which the villa stood; and in the next arable field are the remains of an ancient cromlech, two upright stones of which now only remain, although within memory there existed a third, and the whole was capped by another large stone. All these remains, as we understand, were inclosed within a rectangular earthen boundary, inclosing a space of about two acres. Walls within were soon traced, running at right angles, and the excavations, as they proceeded, disclosed no fewer than thirteen or fourteen rooms upon the same level, two of the floors of which had been provided with hypocausts. The floors had been broken up and destroyed, but some of the tessellæ were scattered among the earth, and part of the columns which had supported them, which had been made of bricks of the usual height and form, though older materials had also been used up along with them, and the portion of a pilaster, or small column, was found employed as one of the supports. Prebendary Scarth inferred from this that the villa had been, at some epoch, rebuilt or enlarged, and, as one side of the pilaster was weather-worn, it seemed to have formed part of a building of earlier date. At the south-eastern angle of the villa, when the walls had been traced to their limit, a stone water-course was laid bare, and followed until its outlet was ascertained. At the south-western end, the paved court was found, which had contained within it a small garden, probably for flowers. On the north side of the larger hypocaust was found a solid block of masonry, which

Prebendary Scarth thinks may have been the basement of an elevated part of the building, such as we find preserved in the wall-paintings preserved at Pompeii, and which appears to have consisted usually of a square turret, from which the whole of the farm-buildings could be over-looked. This arrangement, he adds, is followed to the present day in Italian villas, and we find the same in mediæval buildings, as at the abbot's house at Wenlock, Salop, and in the Deanery at Wells. The usual relics found on the sites of Roman buildings were met with in abundance, such as tiles, roofing slates, fragments of frescoes from the walls, and a portion of the leg of a small marble statue; as well as abundance of pottery, including Samian ware; good specimens of glass; bones of animals, and tips of the antlers of deer, some bearing marks of the cutting tool, and bone hair-pins, and other small objects. As usual, oyster-shells were found scattered about. The coins, which were all of copper, with the exception of one silver one, were numerous, and ranged from A.D. 270 to 455, the latter a very late date for a Roman coin found in Britain, and Mr. Scarth thinks that we may conclude from it that the villa "was occupied by a Romano-British master till the time of the Saxon conquest, when it shared the fate of the many Roman villas which once stood around Bath." This villa, he considers, from the appearance of the remains, to have formed a plain oblong, similar to that found at North Wraxall. Remarks were made by several of those present at the meeting, chiefly on questions relating to the cultivation of gardens by the Romans in Britain, and on the use of window-glass. Now, however, so many examples of window-glass, thick and thin, have been found on Roman sites in this island, that there can be no doubt whatever of its having been in use here in Roman times. The cromlech, too, was a singular object to find in this juxta-position with a Roman villa, and caused considerable surprise. One of the speakers suggested that it was the dog-kennel of the house.

Much has been heard of late of the forgery of antiquities, and especially of FORGED FLINT IMPLEMENTS, for which East Yorkshire has become rather notorious. Some interest has just now been excited by the circumstance that the principal, if not sole author of these forgeries, whose name was Edward Simpson, of Sleights, near Whitby, but who was better known by the nickname of "Flint Jack," and sometimes by that of "Cockney Bill," has just been convicted of theft at Bedford, and is now confined in Bedford gaol for twelve months. Forgery of this kind is, of course, closely allied to dishonesty of all other kinds. In a recent number of the *Malton Messenger*, the history of this man's career appears to be traced still farther back, and Simpson appears not to have been his original name, but he is stated to have been first known as Jerry Taylor, and to have been a small farmer, residing at Billery Dale, the scene of his earlier forgeries, which he had been in the habit of carrying to Whitby for sale, for some years previous to 1855. He also took to forging British urns, and so cleverly, that many people were deceived. We are told that, under his name of Cockney Bill, he one day sold some urns to a gentleman at Bridlington, one of which fell out of

the purchaser's hands, and was broken into fragments. Cockney Bill took the pieces home, returned the urn perfect, and was rewarded for his trouble. A few days afterwards, in sweeping the corners of the room where the urn fell, a large portion of the bottom and side of the original urn was found. This opened the gentleman's eyes, and convinced him that Cockney Bill was an imposter. One of this man's chief occupations was collecting fossils, and even in this he is said to have become notorious for his deceptions.

The newspapers announce, after some of the local papers, apparently interesting discoveries of ROMAN REMAINS brought to light at CIRENCESTER. In excavating for some works at the New Cattle Market, the excavators came upon what had evidently been part of the Roman cemetery, and dug up two rather small stone sarcophagi, each containing the remains of a child, and three sepulchral urns, containing burnt bones. In one of the urns several objects were found, including a terra-cotta lamp, ornamented with figures, what is described in the newspaper as "a safety-pin, on the same principle as those in use at the present day," a bronze fibula, four coins, and one of the small glass unguent bottles, commonly called lachrymatoria. In another part of the town, some men engaged in excavating for cellars, on land in the New Road, came on what is described as the remains of a hypocaust, and found a number of small works in metal and bronze, and other relics of the Roman period. It is to be hoped that some more careful and intelligent account of these discoveries will be published. T. W.

PROGRESS OF INVENTION.

THE OXYHYDROGEN LIME LIGHT.—The applicability of this very brilliant light is greatly limited by the very considerable size of the reservoirs required for the gases, and the cost of the latter. An ingenious American appears to have very much lessened, if not removed, these difficulties. He uses for reservoirs iron cylinders capable of sustaining very great pressure, and condenses each of the gases into that one destined for it. Gasholders of this kind, able to sustain a pressure of fifty pounds to the square inch, and large enough to hold each fifty cubic feet of gas, are of a very moderate size and weight. Cylinders two and a half feet long and nine inches in diameter cost about a dollar for every fifteen pounds to the square inch pressure they are capable of sustaining. They can be filled with the gases at a very moderate cost; with oxygen at the rate of little more than a shilling per cubic foot, and with hydrogen at one-tenth of that price. He has also improved the jet used for burning the mixed gases. The compactness of this apparatus promises to greatly extend the sphere of utility of the oxyhydrogen lime light, the appliances for which have hitherto been so cumbersome and inconvenient.

NEW MODE OF CONSTRUCTING BARRELS.—It is difficult to prevent

ordinary barrels from leakage when filled with certain liquids, and this imperfection very often, as for example in the case of the petroleum and coal oils, is not unattended with danger. Barrels are now formed in the oil districts of America which are free from all imperfections of this kind; while, at the same time, they are light, strong, and inexpensive. They are formed by wrapping spirally round a mould, representing the interior of the intended barrel, strips of white oak, and crossing them with other slips, that are attached to them by a glue which is adapted to the purpose. This process is repeated until the requisite strength and thickness are attained, which, in ordinary cases, is when there are twelve or fourteen layers thus crossing and attached to each other. The heads are formed in a similar way, and are firmly united to the bodies.

Step for Shafting.—A serious mechanical difficulty is experienced on account of the great pressure which is sometimes exerted against the step in which an upright shaft revolves. The friction produced, and the heat by consequence developed, has often led to the welding together, or the fusion of the metals, notwithstanding the attention paid to lubrication. This inconvenience exists whenever a thrust is exerted by the shaft, in whatever direction that thrust may be, whether upwards, downwards, or laterally; and hence great difficulty has arisen in making suitable provision for resisting the thrust of the screw shaft, where, by acting within the vessel, it gives rise to propulsions. Many contrivances have been proposed, and several have been used to meet the difficulty. A recent, and apparently a very effective, invention, intended for this purpose, consists in making the end of the shaft play against chilled iron balls placed in a cup-shaped receptacle. The end of the shaft is so formed that it acts on the balls at an angle of 45°, and presses them against the rim of the chamber which contains them; and it is so arranged, that the difference between the diameter of the circle they traverse and the rim is such as to give rise to a uniform rotation, and therefore to a uniform wear and tear. This contrivance appears particularly well adapted to the steps of turbines, which, when the column of water is high from the great pressure sustained and the enormous velocity of rotation, present very great difficulties in this respect. To a certain extent, indeed, the impossibility hitherto of obtaining a suitable step has set limits to the height of the column of water that may be utilized by them. Should this contrivance be found to answer, as the rubbing is changed into a rolling friction, the difficulty will be entirely got rid of.

Preservative Coatings for Metals.—One of the most effective modes of preserving the common metals consists in coating them with a thin film of gold or platinum. This, however, is attended with expense and trouble; and the same object may be as well, if not better, attained by coating with oxides. For this purpose, however, it is indispensable that the oxides should be made to adhere with great tenacity, a circumstance which long prevented the preservative qualities of oxides being fully utilized. The oxides of iron and lead are the most suited for preservative coatings, especially as they are capable of sustaining, without change, a very elevated temperature.

When oxide of lead is employed, three parts litharge, four parts caustic potash, and forty parts water are boiled together, and as soon as the solution is complete, and has been allowed to cool, forty parts water are added to it; after which it is transferred to a porous vessel, which is placed in water acidulated with one-twentieth part nitric acid. The article to be coated is placed in the porous vessel, and a metallic plate in the dilute nitric acid, the article being connected with the positive, and the plate with the negative pole of a constant battery. In a few minutes the article is covered with a fine dark brown coating of peroxide of lead, which is not in the least disturbed by the burnisher. During the process the litharge is peroxidized by oxygen derived from decomposed water. A coating of oxide of iron is formed by heating protosulphate of iron and ammonia, and using the liquid thus obtained in the same way as the lead solution. It will not answer with articles of copper, on account of the effect produced on that metal by ammonia. The thinner the film of peroxide of iron thus formed, the more adhesive it is; and therefore the process should be continued only until a sufficiently good colour is obtained, which takes place in a few minutes. The iron is peroxidized during the process in the same way as the lead. The article to be covered should in all cases be well cleaned, and be roughened with pumice stone.

Curve produced by a Vibrating String.—A very simple means has been devised for rendering the curve produced by a vibrating string visible. For this purpose the string is illuminated by a bundle of solar rays, reflected by a heliostat. In the path of these rays, a little in front of the string, is placed an opaque disc, presenting transparent diameters at right angles, and capable of revolving on an axis which is at right angles to its plane, so as to make a few revolutions per second. On the other side of the string is fixed a lens of short focus, which forms an enlarged image on a white screen that is placed at the distance of two or three yards. The curve thus obtained will be distinctly visible to the audience of a lecture room.

Self-Registering Electric Thermometer.—A very sensitive and efficient instrument of this kind has been invented by General Morin. It consists of a thermo-electric pile, and a modified multiplier. The thermo-electric pile, which is on the principle of M. Becquerel, consists of thirty rods of iron and maillechort, ranged in parallel grooves, that are formed around a cylinder of wood about two inches in diameter, and have their alternate extremities, which project about three-quarters of an inch beyond the ends of the cylinder, soldered together in pairs. The number of rods that should be employed will depend on the intensity of the current which it is intended to produce when the pile is in operation—that is, when one end is kept at a constant temperature by means of melting ice, and the other end is in the medium, the temperatures of which are to be registered. The multiplier, which the current from the pile is made to traverse, consists of two bobbins, in the centre of which a magnetized needle is suspended by a silk fibre. When in use, the needle should, if no current is passing, lie in the plane of the

magnetic meridian. A wire which is fixed in the centre of the needle, and by the upper extremity of which it is suspended, carries at its lower extremity another needle that is of copper, well balanced, and having at one end a point which projects downwards. This point is intended to mark the deflections of the magnetized needle, produced by the thermo-electric current. For this purpose there is placed under it horizontally an annular disc about two inches in diameter, which carries a disc of paper, and is supported on an upright rod, to which a regular movement of rotation is imparted by clockwork, and which besides, at fixed intervals of a few minutes, is made to ascend and descend vertically by means of a cam. When the disc of paper is raised it comes in contact with the point which projects down from the copper needle, and is pierced by it, since the copper needle is prevented from moving away by an annular disc that is placed over it, and affords a support to it when the paper and point come in contact. The redescent of the paper disengages the point. Thus the deflections of the magnetic needle, and therefore the changes of temperature, are registered, the marks on the paper, if connected by lines, forming a curve. Unless the trepidation which arises from the extreme mobility of the needle are prevented, the registrations can be effected only at certain intervals of time; and in every instance the multiplier must, by means of a case, be protected from currents of air.

New Process for obtaining Oxygen or Chlorine.—This process, which is due to M. Mallet, is founded on the properties possessed by protochloride of copper (Cu_2Cl) of absorbing oxygen from the atmosphere, and becoming oxychloride ($CuCl.\ CuO$), which, when heated to a temperature of 400° C., gives up the oxygen, and again becomes protochloride; the process being capable of repetition, without loss, any number of times with the same protochloride. The latter, to prevent igneous fusion, is mixed with some inert substance, such as sand; and on the large scale the retorts should be capable of rotation, for the purpose, during the separation and reabsorption of oxygen, which may be effected in the same vessel, of equalizing the temperature and keeping the materials well mixed. On the small scale, the process may be carried on in a glass retort, from which the protochloride is removed when oxygen is to be reabsorbed. Reabsorption takes place rapidly with a suitable current of air, especially if the materials are slightly moistened. The same materials and apparatus may be used for obtaining chlorine. For this purpose hydrochloric acid is added to the perchloride after it has absorbed oxygen. The gaseous chlorine disengaged in soda works may be used on the large scale. Bichloride of copper is formed, and chlorine is obtained from this.

Heliochromy on Paper.—The production of pictures in their natural colours has long excited the utmost interest, and will continue to do so until complete success in that direction shall have crowned the efforts of the photographer. What has been already done, though very far from what might be wished, is enough to afford well-grounded hope of the ultimate attainment of so desirable an object. Progress in this department of photography is, no doubt,

slow; but it is something that pictures in their natural colours can now be produced which undergo but little change in a year. Such a result has been obtained by the method of M. Alp. Poitevin, and on paper. He has now made public the methods he uses for the preparation of the paper. A film of ordinary chloride of silver is formed on the surface of photographic paper which has not been albuminized, by bringing one side of each sheet in contact with a solution of chloride of sodium containing ten per cent. of the chloride, and after drying, with a solution of nitrate of silver containing eight per cent. nitrate; or by brushing over one side of the paper uniformly with a mixture consisting of equal volumes of a saturated solution of bichromate of potash, and of a solution of sulphate of copper containing ten per cent. of the sulphate, drying the paper in the dark, applying the prepared surface to the solution of nitrate of silver, removing the excess of nitrate by abundant washing with water, and at the last washing adding, drop by drop, hydrochloric acid until the red chromate is changed into white chloride of silver. To obtain the violet subchloride, a small quantity of a solution of chloride of tin, containing ten per cent. of the chloride, is poured into a dish in which the prepared paper is immersed in water, and without withdrawing the paper from the dish it is then exposed to light in the shade. After about six minutes the required deep violet tint is attained, and the exposure to light must be stopped. The paper is then well washed, and dried in the dark. Its sensibility in this state is very slight, and it may be kept for a considerable time in the dark. The paper thus prepared is best sensitized by means of a mixture of bichromate of potash and sulphate of copper. The fixing agent is water acidulated with sulphuric acid, or, which is preferable, a very dilute solution of bichloride of mercury, similarly acidulated with sulphuric acid. The acidulated water dissolves certain compounds of silver which are formed in spots; and, after the picture has been dried in the dark, it is so little sensitive to light that it will keep very well in an album, and may without injury be looked at with artificial or even diffused light.

Production of Iron from Copper Ore.—Certain ores of copper leave, as residue, after the copper has been extracted, a nearly pure oxide of iron, which would be very valuable, as a source of iron, were it not that its state of minute division renders its reduction by the ordinary methods impossible. It has, however, been found that the difficulty may easily be removed. For this purpose, it is only necessary to agglomerate the oxide into masses of convenient size; which is effected, by drying it, until it contains only about fifteen per cent. water, mixing it with five per cent. hydraulic cement in powder, and sifting the mixture; then moulding the latter by means of any of the machines ordinarily employed for making bricks, considerable pressure being applied, and exposing for some days to the air. The masses thus obtained are sufficiently cohesive for reduction in any of the furnaces used in the iron manufacture. The addition of the hydraulic cement is an advantage, rather than the contrary, since its materials serve as a flux.

MISCELLANEOUS.—*Staining of Wood.*—The aniline dyes are now, with excellent results, applied to the staining of the softer woods, so as to impart to them the appearance of the more valuable. And the process is the more satisfactory, as the wood is coloured throughout its whole substance. To effect this, the air is exhausted from the pores of the wood, after which the aniline dye is injected. ——*Production of Blacks by the Daguerreotype Process.*—The blacks ordinarily produced by the daguerreotype picture are merely negative; that is, they are due simply to the absence of light, which is reflected away from the eye by the polished surface. Some time since it was found that they might be obtained by acting on the sensitized plate with two complementary colours in succession. More recently, M. Niepce de St. Victor has discovered a means of producing them at once, and by a simple process, that consists in plunging the plate, which has been prepared as for the production of the natural colours of objects, into a bath, formed with fifty centilitres of alcoholized soda to one hundred grammes of water, containing a very small amount of common salt; raising the temperature to 60° Cent., and keeping the liquid, which is to be constantly stirred, at that temperature for a few seconds; then taking out the plate, rinsing it well with water, and heating it. The slight reduction of the chloride of silver which has taken place will have given the plate a violet blue tint; and if it is now covered with a varnish consisting of dextrine and chloride of lead, it will afford blacks along with the other colours. There are modes of intensifying the blacks thus obtained, but they are attended with certain inconveniences which render their application not desirable.

LITERARY NOTICES.

DESCRIPTIVE ASTRONOMY. By GEORGE F. CHAMBERS, F.R.A.S., of the Inner Temple, Barrister-at-Law. Oxford, at the Clarendon Press.—A few years ago, Mr. Chambers brought out a book on Astronomy, and the present work, though not so acknowledged in the title page, is a second and enlarged edition of the first one. Any one taking up the book, and led by the title page and preface to regard it as a new one, and discovering on examination that it is simply an improved edition, would consider that he had not been treated in the usual straightforward way, and we cannot but regard it as a mistake in so respectable a firm as that of Messrs. Macmillan and Co., to have permitted Mr. Chambers to give a fallacious aspect to his really useful compilation. Taking the book altogether, it will be found very useful for amateur observational astronomers, as it brings together, in a compact form, a considerable range of information constantly required in private observatories. The plan is, first to describe, in a brief manner, the sun, and the larger planets, then follow chapters on eclipses of various kinds, transits of the inferior planets and occultations. "Physical and Miscellaneous Astronomical Phenomena" occupy several chapters. Comets receive notice

in several more, and the list of "Comets whose orbits have not been computed," published originally in our pages, reappears, without any acknowledgment of its previous issue. "The Starry Heavens" supply themes for eleven chapters, which include a catalogue of variable stars, and some other useful lists. Astronomical instruments, and the mode of adjusting and using them usefully, occupy nine chapters, after which comes a "Sketch of the History of Astronomy," and remarks on meteorites, and the book concludes with a series of astronomical tables. From this sketch of contents, the utility of the work will be apparent, though it is defective in many particulars, and exhibits rather a plodding industry in extracting from other books, than any originality of conception or power of exposition. Its chief merit is that it supplies a gap, and we could not indicate any one volume, extending over the same range of subjects, and compiled with the same regard to the average wants of amateurs.

At page 35, the reader will notice a long passage on the comparative sizes of the sun and planets, and of the orbits of the latter, taken almost *verbatim* from Sir J. Herschel's *Outlines*, without acknowledgment; and the explanation of the harvest moon, at page 80, is copied in the same way, and printed as if it were original. There are many other appropriations without adequate confession. At page 502, nebulæ are spoken of as "probably all stellar," thus ignoring the important discoveries of Mr. Huggins. Mr. Chambers speaks of his not being quite satisfied with the illustrations of nebulæ, etc., and we believe he made the same observation in the first edition of his book. Some are tolerable, and others so bad, that they ought not to have reappeared. In Plate xxiv. is a most preposterous view of the cluster 47 Toucani, stated to be "drawn by Sir J. Herschel." This cluster is figured in the *Cape Observations* of the distinguished astronomer, whose name is thus made use of, but his figure, in its main features, bears *no resemblance* to the remarkable object which Mr. Chambers supplies. We feel it is right to make great allowances for popular works that endeavour to figure delicate clusters and nebulæ, as they are extremely difficult to engrave satisfactorily, but no artist and no compiler can be justified in issuing, on the authority of a great observer, such a pure invention and fiction as the plate we complain of.

ANNUAL REPORT OF THE BOARD OF REGENTS OF THE SMITHSONIAN INSTITUTION, showing the Operations, Expenditures, and Condition of the Institution for the year 1865. WASHINGTON, 1866.—In a former number we gave an account of the "Smithsonian Institution," and of the valuable character of its labours. The present report shows that much good work was done in the period to which it refers. The publications embrace *A Description of Magnetic Observations made at Girard College; Palæontology of the Upper Missouri; Cretaceous Reptiles of the United States; Astronomical, Magnetic, and Meteorological Observations within the Arctic Circle;* an *Investigation into the Orbit of Neptune.* These are quartos, and the octavo series comprises a *Review of American Birds in the Smithsonian Collection; Researches upon the Hydrobriinæ;* a continuation of the *Synopsis of American Land and Fresh-water Shells, etc.* From the Secretaries'

Report we learn that the Polar Observations indicate a smaller value than had been hitherto assigned to the polar flattening of the earth. "The compression, as deduced from Mr. Schott, from all the observations of the expedition under Dr. Hayes, is one 377th part of the polar radius. The excess of the number of vibrations in a day at Port Foulke, over the number made by the same pendulum in the same time in the Harvard Observatory, was 129½." Further experiments with the same pendulum are in progress, to ascertain the number of its vibrations at various points of the meridian on which Port Foulke lies, in order to obtain a series of independent observations of the curvature of the earth. Curious information as to the climate of the polar regions seems to have been obtained; thus, Port Foulke, which is in the vicinity of open polar water, showed 26° higher temperature than Van Rennselaer Harbour, only 53 miles distant from it. The maximum difference was 46½ on the 20th March, 1861. The warmest day was on the 15th July, when the temperature was 41°·6 F., and 16th Feb. was the coldest, being —28° F. The N.E. winds coming over Greenland were found to be the coldest, and the S.W. the warmest, but "the effect of the various winds on the whole is small, not exceeding an elevation or depression of more than 1½° from the mean. The most intense cold was experienced during calms. Snow and rain exert much more influence on the winter temperature than wind; on an average, in winter, during every fall of snow, the temperature was elevated 8°·6 F., and in summer fell 1½° during a fall of snow or rain." Clear days in winter were on the average the coldest by 3½°, and the highest in summer by 0°·8. The quantity of the stream of air passing in the course of a year over the field of observation was nearly 60,000 miles.

The *Smithsonian Report* for 1865 has the usual appendix, in the shape of a series of useful papers selected from various sources, and is well adapted to diffusing scientific knowledge.

Modern Arithmetic; a Treatise adapted for the School and for Private Study, containing numerous improvements in aid of the Preparation of Candidates for Public Examinations. By the Rev. John Hunter, M.A., formerly Vice-Principal of the National Society's Training College, Battersea. (Longmans.)

An Easy Introduction to the higher Treatises on Conic Sections. By the Rev. John Hunter, M.A. (Longmans.)

These publications of Mr. Hunter evince a clear perception of the difficulties of students. The arithmetic, especially, is very superior to most of the works in general use.

The Twin Records of Creation, or Geology and Genesis, their perfect harmony and wonderful concord. By Geo. Victor le Vaux. (Lockwood.)—This is one of those unfortunate publications which will be liked best by those who are in the most complete accordance with the writer's theology, and who possess the least knowledge of geological investigation.

A Monograph of the British Fossil Crustacea, belonging to the Order Merostomata. Part I. Pterygotus Anglicus, Agassiz. Pages 1—44. Plates i.—ix. By Henry Woodward, F.G.S., F.Z.S., of the

British Museum. (London: printed for the Palæontographical Society, 1866.)—Mr. Woodward unites the Eurypterida and Xiphosura under the order Merostomata, proposed by Dana for king crabs only. The term "Merostomata" is derived from μηρος, a thigh, and στόμα, a mouth; the peculiarity of the order being that the creatures it includes "have a mouth, furnished with mandibles and maxillæ, the terminations of which become swimming feet and organs of prehension." The present part of Mr. Woodward's work commences with some important introductory observations, and then describes the *Pterygotus Anglicus*, with the help of numerous figures of fossils, and of recent crustacea, for comparison with the former. Our readers will recollect an important paper by Mr. Woodward in our vol. iv., p. 229, accompanied by a fine plate. To this paper we may refer for highly-interesting information on a very curious group of animals. The present monograph will evidently take a high rank amongst similar publications, and it is illustrated by numerous well-executed plates.

The Student's Text-book of Electricity. By Henry M. Noad, Ph.D., F.R.S., F.C.S., Lecturer on Chemistry at St. George's Hospital, author of a "Manual of Chemical Analysis," "A Manual of Electricity," etc. With Four Hundred Illustrations. (Lockwood and Co.)—Since the publication of Dr. Noad's *Manual of Electricity* we have constantly used it as a book of reference, and found its merits of a high order. The present volume is founded upon it. An admirable method of compression is employed, and the type, though smaller than that of the Manual, is very clear. The various subjects are all brought up to date, and, as a student's book, none that we are acquainted with can compete with it.

The Art of Wood Engraving: a Practical Handbook. By Thomas Gilks. With numerous Illustrations by the Author. (Winsor and Newton.)—Mr. Gilks enjoys an excellent reputation as a wood-engraver, and the present pretty little volume explains step by step the various processes by which a wood engraving is made. The lessons are well selected and simply explained, and cannot fail to prove useful to those who wish to practise an elegant art, and to be acquainted with the principles on which it is conducted.

A Description of the New Telescopes with Silvered Glass Specula; and Instructions for Adjusting them. By John Browning, F.R.S. (Straker and Sons.)—The great importance of the new telescopes gives value to this pamphlet in explanation of their peculiarities. Mr. Browning certainly does not overrate their merits. One which we have, and others which we have seen, deserve more praise than his modesty has assigned to them. This pamphlet contains a great deal of valuable matter.

Hints on Spectacles: When to Wear, and how to Select them. By W. Ackland, Surgeon. (Horne and Thornthwaite.)—The primary object of this pamphlet is no doubt to sell the spectacles made by Messrs. Horne and Thornthwaite, in connection with whose establishment Mr. Ackland is well and honourably known to the scientific world; but it differs, like Mr. Browning's pamphlet, from an ordinary trade puff. It contains a well written exposition of the

optical principles of *the eye*, and of the instruments by which its vision may be assisted, and thus having a scientific value, it comes within our rule of publications that we can notice and commend. It is not for us to say, out of a multitude of other respectable opticians, which is the best house for spectacles, but we strongly recommend our readers to avoid cheating quacks, and to make their purchases of reliable firms.

GEOLOGY FOR GENERAL READERS. A series of Popular Sketches of Geology and Palæontology. By DAVID PAGE, F.R.S.E., F.G.S. Second and enlarged Edition. (Blackwood and Sons.)—Mr. David Page is one of the most successful epitomizers and popularizers of science, and in this capacity he merits no small commendation. The present edition of a well-known work evinces his usual skill and care. It belongs to a class of book gradually finding its way into all the better kind of schools, and is well suited for family reading.

THE BIRDS OF NORFOLK, with Remarks on their Habits, Migration, and Local Distribution. By HENRY STEVENSON, F.L.S., Member of the British Ornithologists' Union. In two vols., vol. i. (Van Voorst, Norwich, Malabret & Stevenson.)—The present volume is an excellent specimen of a very valuable class of works, which, under the form of contributions to local fauna, not only answer the purpose of a useful catalogue, but contribute efficiently to the science of Natural History. An accurate list of species inhabiting or visiting any district is in itself an important contribution to knowledge, but much more so when, as in the case of Mr. Stevenson's book, it is accompanied with a large amount of interesting information concerning the habits, food, structure, etc., of the creatures described. Although Norfolk is by no means one of the most beautiful of English counties, its position and physical characteristics assign to it a very high degree of ornithological importance. "Bounded on the north and east by the German Ocean and the great estuary of the Wash, Norfolk is insulated, as it were, in every other direction by rivers, the Waveney and Little Ouse dividing it from Suffolk on the south, and the Great Ouse, Welney, and Nene from Cambridgeshire, on the west." It is favourably situated, as Mr. Stevenson observes, with reference to Holland, the west coast of Norway, and the north-east coast of our own island. Its coast line makes it a convenient place of "call," and thus it is that "a classified list of the birds of Norfolk shows an excess of imigrants over residents, amounting to nearly two-thirds, while the latter are even outnumbered by rare and accidental visitants." The local peculiarities of the county are likewise favourable to ornithological variety. The "Broad district" is full of shallow lakes and lagoons, locally termed "Broads." The "Cliff district" is sandy, and contains an admixture of arable land, pastures, woodland, and heath. The "Weal district," so called from the sandy hillocks or "weals" lying between the sea-shore and the cultivated land, with flat oozy plains between them. The "Break district" has a light thin soil lying on chalk, partly broken up by the plough, and many of these "breaks," or broken up places, abandoned to wild birds and game. "The effect of high winds after dry weather in this district," says

Mr. Stevenson, "is not easily described. The whole air is filled with sand, till it resembles a London fog. Nearly every particle of fertilizing matter is blown away from the land, as is shown for years afterwards by its barrenness." Then there is the "Fen district," and the "Enclosed district," names sufficiently significant of their character, if allowance is made for the progress of cultivation.

The detailed account which Mr. Stevenson gives of these districts is very interesting, and they afford appropriate conditions for the habitation or sojourn of many rare birds. The descriptions given by Mr. Stevenson of the decline or disappearance of particular birds, as artificial changes have been introduced in the physical features of the locality, are very important, and not less so that of the settlement and multiplication of other species for whom the new conditions operated favourably. Thus within thirty or forty years, three species of harriers have disappeared from the fens, in consequence of their drainage by machinery. Ruffs and reeves have likewise vanished, "but the red-shank was induced to return to its old haunts by the extraordinary flood of 1852. . . . This same flood acted in like manner upon the black tern and the black-headed gull, both of which, in 1853, stayed to breed in places which had been so long abandoned by them, that their names were even unknown in the land."

The present volume begins with the white-tailed eagle and ends with the quail, and includes descriptions of the visits and habits of many rare birds, waxwings, crossbills, etc., and of Pallas' sand-grouse, of which a beautiful coloured plate is given. Our readers will recollect a paper on the curious fact of the appearance of this bird in England, which we published in our fourth volume.

In the chapter devoted to the kingfisher, Mr. Stevenson utters a protest against the destruction of these birds to furnish ornaments for ladies' hats; and it is really abominable, that one of the most interesting British birds should be in danger of absolute extirpation in obedience to a mere whim of fashion, and to an unfortunate over development of the monkey habit of imitation. He also records a visit to a kingfisher's nest. It was placed in a hole like that of a rat in a "dyke," or drain, about a foot below the top of the bank, and the same distance from the water. The hole sloped gradually upwards from its mouth, and terminated in a round chamber, "filled with the remains of fish in every stage of decomposition. There were seven eggs laid exactly in the centre on a bed of pure white fish bones, and surrounded with fish refuse swarming with maggots. The fish bones when cleaned weighed ten ounces and thirty grains, and must have represented a great quantity of the small fry which form the chief part of the kingfisher's food. Mr. Stevenson noticed remains of water-beetles, but not a particle of grass, straw, or similar material.

Strongly recommending his work, as both interesting and valuable, and further mentioning that the frontispiece to the first volume represents one of the "Norfolk Broads," we leave it with the intention of completing our notice when the second volume appears.

CORRESPONDENCE.

The following letter is from the Rev. J. D. La Touche:—

"Shadows during the Solar Eclipse.

"It has often been remarked that the light during an eclipse of the sun is of a very peculiar character, differing not only from the diffused light of a hazy day, but from that of a less luminous body, such as the moon. This arises, I believe, to a great extent, from the peculiar nature of the shadows thrown by all objects in consequence of the great change which has taken place in the shape of the surface from which the light proceeds.

"My attention was attracted to this during the late eclipse, when, in order to give a large party of school-children simultaneously a view of the wonderful sight, without the aid of smoked glass, I made a few small holes in a piece of card, and holding this at some distance from a sheet of white paper, just as many beautiful crescents appeared, exhibiting to my much-pleased audience, the progress of the eclipse.

"In making this experiment, however, it was soon manifest that not only the image of the sun, transmitted through the little holes in the card, was changed from the ordinary circle (to which, by the way, we are so accustomed, that I dare say many, when they behold it, are not aware that it is really an image of the sun itself), but it appeared that the edges of the shadow of the card had also undergone an equally remarkable change.

"Every one must have observed, that around the edges of every shadow cast by the sun, is a gradually softened-off margin or penumbra, which, when the object casting it is at six feet distance from that on which it falls, extends, under ordinary circumstances, for about nine-sixteenths of an inch equally round it on every side. This is caused by the sun being, not a luminous *point*, but a disc of considerable size, every portion of which gives off rays of light. Where, as in the case of the electric light, the luminous body is a mere point, all shadows will be sharp and distinct—even those of hairs will be defined with a clearness which strikes most spectators with surprise; but where the diameter of the luminous surface is considerable, a certain breadth of half-shadow is produced, exactly corresponding to the angle which the disc subtends, and the distance of the opaque body which casts the shadow from the screen on which it is received, and this penumbra will necessarily be modified by the shape of the luminous disc as well. Thus, when the sun is undergoing eclipse, its crescent form will alter the shape of every shadow it gives rise to. In our direction, the diameter of its disc remains unaltered, while in the other it is greatly diminished, causing a corresponding change in the marginal shadow of every object.

"Now, in the late eclipse, at the time of greatest obscuration, the crescent was in a somewhat horizontal position, and accordingly, though all vertical shadows remained of the same width as before, horizontal ones were greatly diminished, and this was very striking in our experiment. When the piece of card, moreover, was caused to turn round in its own plane, a regular proportional change took

place in the shadows of each edge, each diminishing as it approached a position parallel to the line of the curves of the sun's crescent, and increasing as it became perpendicular to it. There was, moreover, observable a peculiar curving upwards of the line of junction of the penumbras of the horizontal and vertical edges of the card at the angles of the shadow, which evidently corresponded to the crescent shape of the sun itself.

"Of course, the shadows of all other objects were at the same time thrown out of proportion. Thus, when the hand was held horizontally and edgeways in front of, and at some distance from, the sheet of paper, its shadow above and below was very much more sharply defined and narrow than under ordinary circumstances, but if it was held vertically, the indistinct penumbra took the place of any distinct shadow.

"These effects were very remarkable, in consequence of the beautiful clearness of the sky here at the time of the eclipse, and suggested the thought, that this considerable modification of other shadows could not but affect the usual aspect of all the objects around, and contribute to the peculiarity of their appearance."

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.—*Feb.* 20.

Warington W. Smyth, Esq., M.A., F.R.S., President, in the Chair.

The following communication was read:—

On the British Fossil Oxen.—Part II. *Bos longifrons*, Owen. By W. Boyd Dawkins, Esq., M.A. (Oxon.), F.G.S.

The author analyzed the characteristics usually assigned to *Bos longifrons*, and concluded that there were none of specific value to separate it from the smaller varieties of *Bos Taurus*. The large series of skulls in the Dublin and Oxford Museums show that *Bos frontosus* of Nilsson is a mere variation from the more usual type. Professor Owen, on the faith of its occurrence on the Essex shore, along with the remains of extinct animals also washed up by the waves, ascribes to this species a Pleistocene age. This inference, on a rigid examination of the premises, turns out to be faulty, and there is no evidence anywhere in Europe that it co-existed with any of the extinct mammals, the Irish elk being excepted. It is very commonly associated with the remains of man, of a date anterior to the Saxon invasion. It was kept in great herds during the Roman occupation, and supplied the legionaries with beef. On the Continent, as in Britain, it is found around the dwellings and in the tombs of the Bronze and Stone folk. Nowhere is there evidence of its having a higher antiquity than the Neolithic age of Sir John Lubbock. It disappeared along with its Keltic masters before the Saxon invaders from the more fertile portions of Britain, and took refuge in the highlands of Scotland and Wales, where it still

survives in the smaller domestic races. In no case has it been found in association with Saxon remains. The inferences to be drawn about it are, first, that it has not yet been *proved* to have existed before the pre-historic age; and, second, that it is the ancestor of the small Highland and Welsh breeds. It is essentially the animal with which the archæologists have to deal, and its only claim for insertion in geological catalogues is the fact of its occurrence in the most modern of all the stratified deposits.

ROYAL MICROSCOPICAL SOCIETY.—*March* 13.

James Glaisher, Esq., F.R.S., in the Chair.

A paper was read by Dr. McIntosh describing gregariniferous parasites found in Borlasia. Mr. Jabez Hogg alluded to the absurd stories in the *Times* and other papers concerning the gregarinæ in the chignons. He stated that empty egg-shells of the louse had been discovered on dirty specimens, and in some other cases a fungoid growth that is associated with ringworm.

Mr. Whitney read a highly valuable and instructive paper on the development of the breathing organs of the tadpole, which he illustrated by a series of large and beautifully-executed diagrams. He showed how the internal gills grew, and caused the atrophy of the external ones by interrupting their blood supply. The internal gills could be seen by stupefying the tadpole by means of a drop of chloroform, and then dexterously cutting away the integument. When fully developed they exhibited beautifully ramified tufts, with efferent and afferent vessels. The true lungs were quite distinct from these internal gills, and were developed at a later period.

It was announced that the annual soiree of the Society would take place at King's College, on the 24th of April.

NOTES AND MEMORANDA.

Polyps of the Hyalonema.—At an excellent soirée recently given by the Old Change Microscopical Society, Mr. Tyler exhibited specimens of the polyp cells attached to the glass rope of the Hyalonema sponge, with the zoanthoid polyps *in situ*. His preparations seem quite decisive in favour of the views of Brandt and Schulze, supported in our pages by Professor Wyville Thomson, and conclusive against the opinion of Dr. Bowerbank, that the supposed polyp cells were excretory orifices of the sponge. In the *Annals of Natural History* for March, Max. Schultze has a paper to vindicate his views of the Hyalonema, in which most naturalists coincide. He speaks of the close resemblance in structure between the long spicules and the shorter ones forming the body of the sponge. With reference to the polyps (*palythoa*), he states that Oscar Schmidt has found a similar polyp parasitic upon a sponge in the Adriatic. He also alludes to the way in which the polyps themselves with their thread capsules may be made visible, as in Mr. Tyler's preparations.

Photographing the Moon.—The Lunar Committee of the British Association have issued a series of tables prepared by the Secretary, Mr. Birt, to show the most favourable periods for photographing, or drawing particular parts. Observers

who can assist the Moon Committee should obtain a set of their tables by communicating with W. T. Birt, Esq., 42, Sewardstone Road West, Victoria Park, London, N.E.

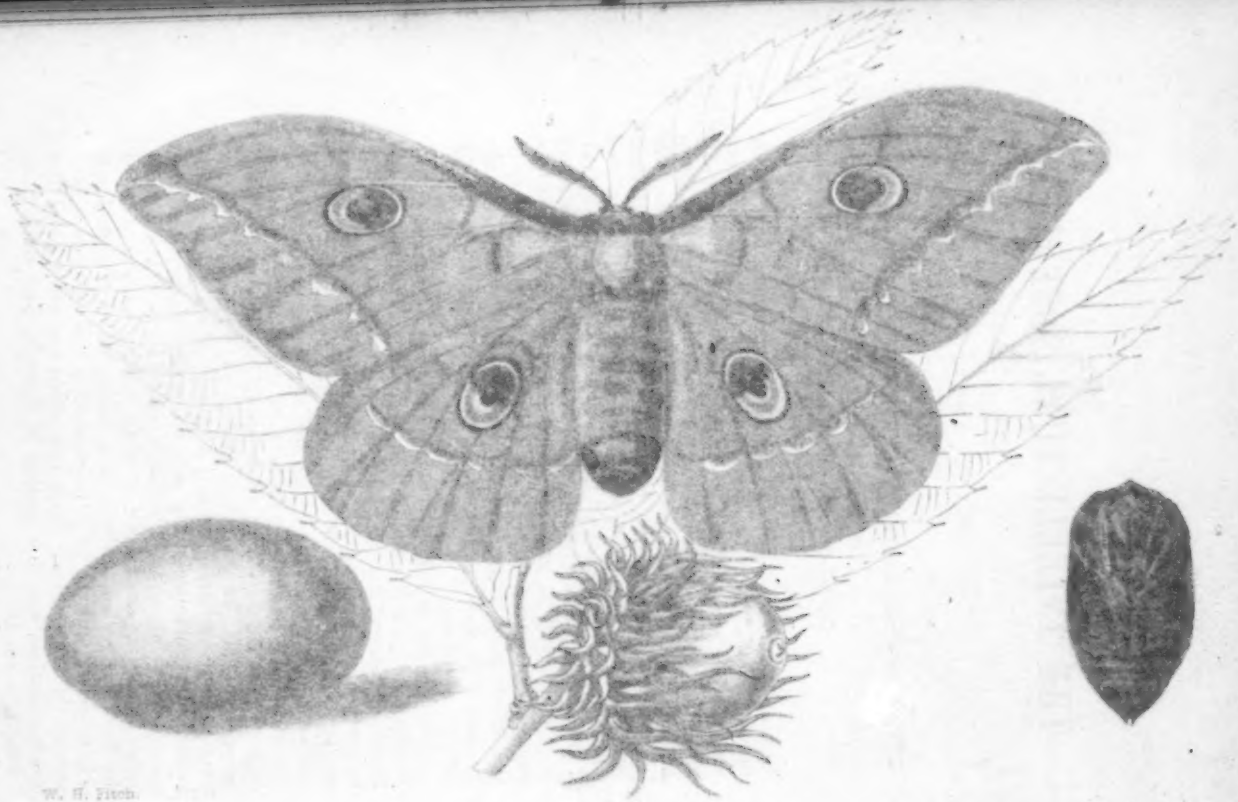
Experiments on Cell Formations.—The *Proceedings of the Royal Society*, vol. xv., No. 88, contains an important paper by Dr. Montgomery on cells. He shows that so-called "organic" cells of cancer and other tumours expand on the addition of water to several times their original size, and at last vanish in the surrounding medium. The nucleus did not always participate in this change. Artificial processes were then adopted, and it was found that when myeline, in its dry amorphous state, was placed in water, slender tubes shot forth from the free margins, "wonderfully like nerve-tubes." When intimately mixed with white of egg the myeline formed "instead of tubes, splendid clear globules, layer after layer, resembling closely those of the crystalline lens formed under similar conditions." "By mixing myeline with blood serum, globules were obtained showing the most lively molecular motion. When the serum somewhat preponderated, the whole globules seemed, after a while, to undergo coagulation, and appeared often as beautifully and finely granulated as any real cell. When this mixture of myeline and serum was spread very thinly over the glass slide, there often started into existence, with the addition of water, small primary globules, round which an irregular mass of granular material became gradually detached from the glass slide. It at last shaped itself into a secondary globule, enclosing the primary one, and constituting with it, down to the minutest details, the most perfect typical cell." . . . "If the amorphous myeline be very thinly spread on a glass slide instead of tubes, there will form bodies looking like rings. They are actually double globules, the inner globule being more transparent than the outer." When dried, and afterwards wetted, the inner globule becomes the nucleus. If serum is added instead of water, biconcave discs are formed like blood corpuscles, but larger.

The Mammoth in the Bay of Tas.—The expectations of finding a complete mammoth in this situation have been disappointed. M. Schmidt, on arriving at the locality, found the remains in an imperfect state. He has brought away hair, skin, and bones, but the internal organs had perished, and he could obtain no positive information as to the nature of the creature's food.

Silurian Life.—The *Proceedings of the Royal Society*, No. 90, contains an account by Dr. Bigsby of a work on Silurian Fossils, which he proposes to call *Thesaurus Siluricus*. He says it "contains 7,553 species, and probably it does not give the tithe of the whole Silurian life yet lying buried under the wilds of the arctic circle, of Hudson's Bay, Labrador, the two Americas, Scandinavia, Australia, India, etc., etc. It appears that the number of species known in 1856 was only 1,995. "In the primordial group," says Dr. Bigsby, "we find numerous representatives of nearly every marine invertebrate, and we have a startling example of the sudden development in very early times of the highest types of molluscan life, nautili, litpites, trilobites, protichnites, etc."

Action of Quinine on the Nerves.—M. Eulenberg states in *Comtes Rendus*, that injecting three to twelve centigrammes of sulphate of quinine under the skin of frogs arrests respiratory movements and the action of the heart. He considers it to operate first on the central foci of reflex action in the spinal chord, and afterwards on the cerebral foci of sensation and movement.

The Solar Eclipse, March 6.—At Madrid, Dr. Aguilor, of the Observatory, was able to make thermometrical observations under favourable conditions of clear sky. He used two of Casella's thermometers, placed out of the direct rays of the sun. Their coincidence all through was very close. March 5, 19h. 50m. they both showed 21°·5. The eclipse was at its maximum at 20h. 54m., and 20h. 55m. the temperature was 7°·8 according to one instrument, and 7°·9 according to the other. The lowest was at 21h., 7°·5 and 7°·6. At 22h. 20m. one showed 26°·8, and the other 26°·5.



W. H. Fitch.

OAK-FEEDING SILKWORM OF CHINA.
Antheræa Pernyi. Guer. Mene.